A COMPARISON BETWEEN THE ROYAL NAVY AND THE UNITED STATES NAVY OF THE SYSTEM ACQUISITION PROCESS AND PROJECT CONTROL

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THESIS

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by

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by

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requirements for the degree of

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December 1977

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This thesis explores the process of major systems acquisition in Britain and the United States. It describes the process of initiation and development of systems from the management view-point, and also the methods used by each government for control of the project and the contractor. The differences between the systems of the two countries are highlighted.

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I. INTRODUCTION

The object of this thesis is to present some comparisons of system acquisition management, or procurement management as it is known in Britain, between the Royal Navy and the United States Navy. As the subject covers a wide spectrum, only certain aspects are presented. One is how an acquisition is initiated and the path it takes through the various phases of the acquisition process. The other is the methods used to control a project from the perspective of the project manager. A further limitation is that only the acquisition of major systems is considered. These are systems which are expected to cost more than certain values or are considered particularly significant by the respective governments. At present the financial thresholds for a system to be considered major are:

	Research & Development	Production
Britain	5 M	10 M
United States	75 M	300 M

In order to provide practical examples the acquisition process of two missiles is described. For the Royal Navy, the acquisition of the Seawolf missile system is described and for the United States Navy, the Standard Missile 2.

In writing this thesis every effort has been made to keep the terminology general so that it may be readily understood in Britain and the United States. Particular terminology or

titles are identified by (UK) or (US) where necessary, although in normal use they would be omitted. The term 'defence agency' is used as the common name for the Ministry of Defence (UK) and Department of Defense (US). Also, the term 'project' is used throughout with no differentiation between a 'project' and a 'programme' suggested. Finally this thesis is written in accordance with the Oxford English Dictionary except where proper names or titles of the United States are used.

A. REASONS FOR THE THESIS

On April 5, 1976 the Office of Management and Budget Circular A-109 (US) (Ref. 1) was issued for use by all United States Executive agencies* and was subsequently implemented by the U.S. Department of Defense Directives 5000.1 and 5000.2 (US) (Ref. 2 and 3) on January 18, 1977. As a part of these documents, significant changes were made to how a project is initiated and to how it is monitored during its early stages. There is still some doubt in the eyes of the United States authorities as to how these directives should be carried out and whether the principles are correct. These aspects are being studied at present as a separate thesis. (Ref 4)

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*An Executive agency is a major U.S. Government operating agency reporting to the President. Examples are the Departments of Defense; Treasury; Health, Education and Welfare; and the National Aeronautics and Space Agency.

To provide a comparison, one of the objects of this thesis is to highlight the differences between the United States and British methods of initiating an acquisition project. This is so that the United States authorities may understand why the British follow a particular path and so that the British authorities may consider if there are lessons to be learnt from the recent changes within the United States. Another objective of this thesis, in addition to the above which concerns the central administrations of the respective defence agencies, is to study how acquisition projects are managed by project offices of each country. This is because there are significant differences between the relationship of the government, which includes the project office, and industry in the United States and in Britain. The reasons for these differences are explained so that a better understanding may be obtained and any worthwhile changes may become apparent.

For the last seven years, project administration in Britain has been influenced by the 'Downey Report' (Ref. 5) and it is only now that results of this method of management are being realised. Therefore, this thesis presents some of the outstanding problems and also highlights some of the differences of opinions that still exist within Britain as to its implementation. The method described in the 'Downey Report' (Ref. 5) will be compared with the existing United States method so that the advantages of each can be presented.

Finally, a better understanding of how and why the other half operates can only be beneficial, especially when it comes to arms sales or cooperative ventures. Therefore in the course of this thesis some of the aspects of system acquisition in each country are described for informative purposes.

B. THE METHOD OF RESEARCH

In this thesis, the aspects of the acquisition process and the project control are broken down into how it logically should happen, how the regulations intend it to happen and how it happens in practice. These are called the normative, prescriptive and descriptive methods respectively. To satisfy the normative and prescriptive methods, part of the research for this thesis was to study many of the publications that are relevant to systems acquisition.

In order to research the descriptive method, the acquisitions of Seawolf and Standard Missile 2 were studied. An overview of these systems is given in section IC. To gather information, visits were made to the respective defence agency project offices and contractors. In the United States, this involved a visit to General Dynamics (Pomona), California and to the project office in Washington. While in Washington, the technical advisors for SM-2 were also visited at the Applied Physics Laboratory of John Hopkins University, Baltimore. To gather information for the Seawolf system, the project office and other involved personnel were visited at the Admiralty Surface Weapons Establishment, Portsdown. The

prime contractors, being the British Aircraft Corporation and Marconi Radar Systems Limited, were also visited. A complete list of all organisations and personnel visited are given in the Appendix. The time spent, and cooperation experienced, in all the interviews was very much appreciated and there appeared to be an atmosphere of frankness in the discussions. In return, any comments or criticisms in this thesis by the author are intended to be constructive and not directed at a particular individual or organisation.

C. AN OVERVIEW OF THE SYSTEMS STUDIED

1. Seawolf/Guided Weapon System 25

In the above heading, Seawolf refers to the missile, and Guided Weapon System 25 (GWS 25) refers to the shipborne tracker and launcher system. Together, it is a close range, command to line-of-sight, point-defence anti-missile system. Initial studies for the system were carried out from 1964, with preliminary development starting in 1967. Full-scale development was started in 1968 and the system is now in production. Trials were carried out in a converted frigate and have been successfully completed. It is at present being fitted to a new class of frigates under construction.

For the complete system there are two prime contractors and many subcontractors. For the Seawolf missile and missile guidance unit, the British Aircraft Corporation (now British Aerospace) are the prime contractors and for the ship-borne tracker and launcher, the prime contractor is Marconi Radar Systems Ltd.

2. The Standard Missile 2

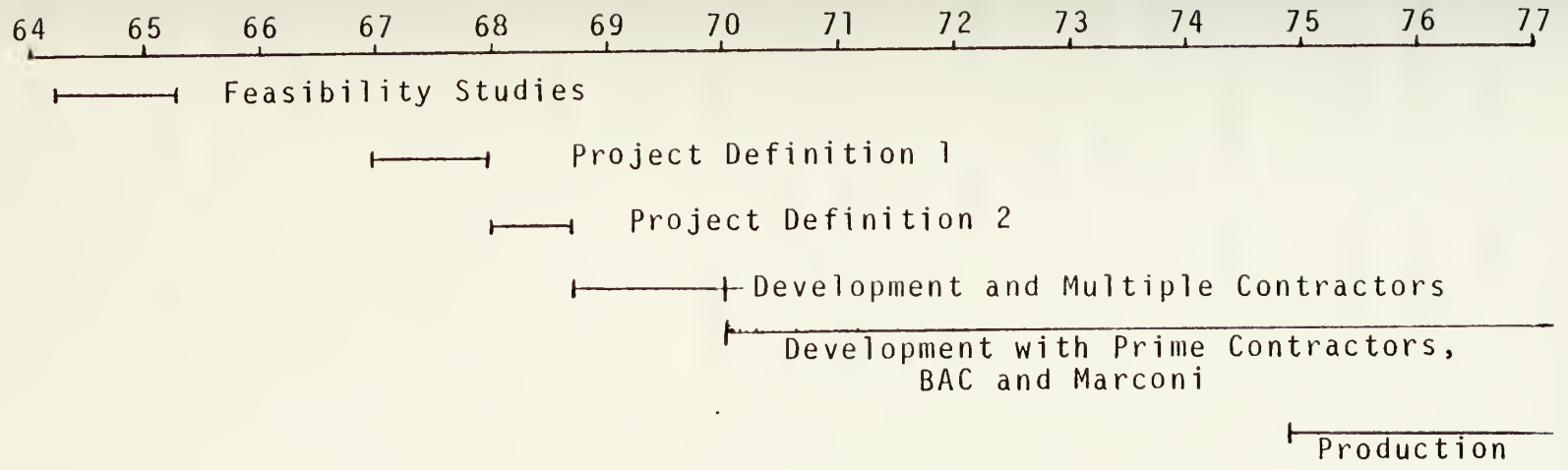
The Standard Missile 2 (SM-2) a medium to long range, semi-active, surface-to-air family of missiles. There are two versions, the medium range one and an extended range one which has an additional boost motor. The SM-2 medium range version is part of the Aegis system and can also be used in improved Tartar systems. In the Extended Range version it will be used in improved Terrier systems.

Initial studies for the Aegis system were carried out from 1964, and SM-2 was not identified until early 1970. The main reasons for the evolution of SM-2 was that it was decided that the Aegis system was to be developed without a missile and that a missile would be developed separately. General Dynamics (Pomona) proposed a modified and improved version of the Standard Missile 1 and became the prime contractor.

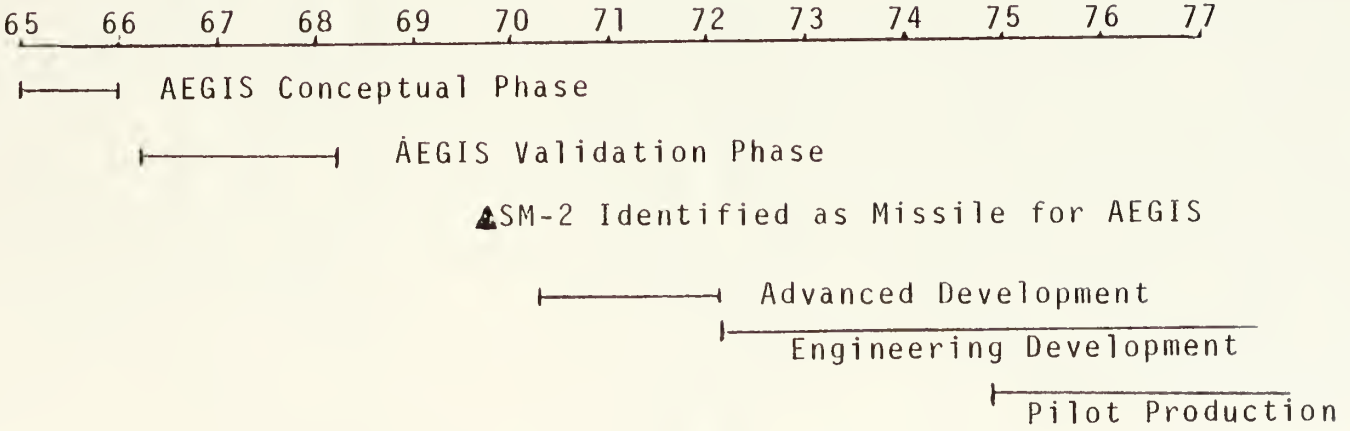
The present position is that sea trials have been successfully completed for the improved Terrier missiles and Aegis missiles. There is a pilot production contract underway for Extended Range Terrier mode missiles with delivery expected to begin in 1978.

Figure 1 shows the major events for Seawolf and Standard Missile 2 acquisitions.

SEAWOLF/GUIDED WEAPON SYSTEM 25



SM-2



THE DEVELOPMENT SCHEDULES OF SEAWOLF AND SM-2

Figure 1

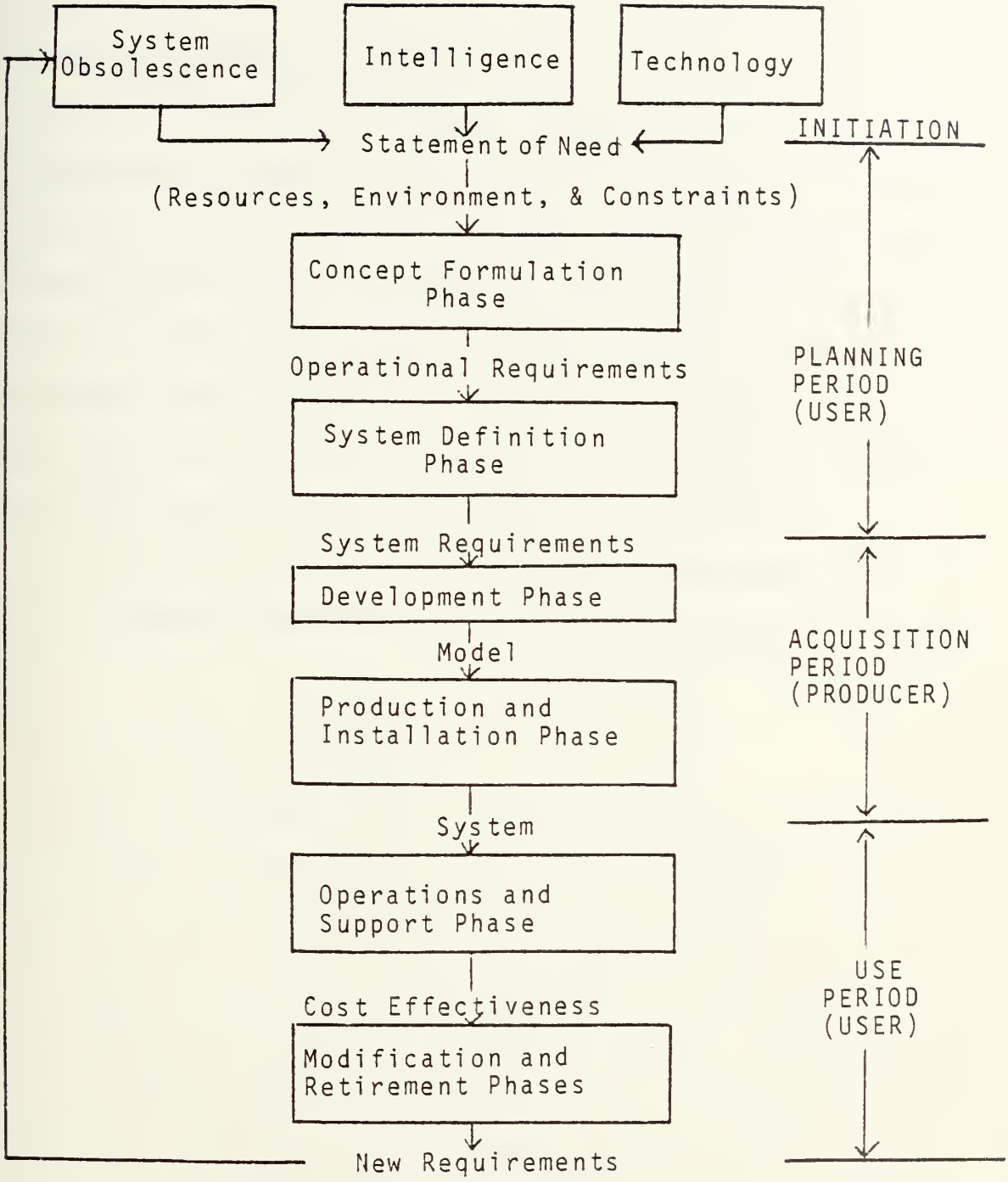
II. THE SYSTEM ACQUISITION LIFE CYCLE

The system life cycle may be said to originate in the perception of a need and to terminate when the system is retired as obsolete. However, designing a system to just meet the need is not usually sufficient. With few exceptions, the system must be able to continue to meet the need over a specified period of time in order to justify the investment in time, money, and effort. Thus, one must consider a system in a dynamic sense - the life cycle or so called "cradle-to-grave" viewpoint. (Ref. 6)

In this chapter the logical or rational process, known as the normative model, will be described. This process is equally applicable whether acquiring a new weapon system, ship, or commercial system. Figure 2 illustrates the overall sequence.

A. THE INITIATION

The systems acquisition process should be initiated only when a definite need is found to exist. Sources of need result from new technology, intelligence (threats), and system obsolescence. The acquisition process is always bounded by constraints such as technology, available resources, the environment, politics and finances, and these constraints are carefully weighed against the importance of the new need. Only when the need is considered over-riding will a firm decision be



SYSTEM LIFE CYCLE

Figure 2

taken to initiate the acquisition process in order to satisfy the new need.

B. CONCEPT FORMULATION PHASE

During this phase the needs and constraints are analyzed and approaches are developed in order to prepare an operational requirement in mission oriented terms (what the system should do operationally) and in sufficient detail to facilitate a decision to enter the subsequent phase. The requirements are based upon a need and activity (threat and mission) analysis. Measures of effectiveness, technical, financial and resource feasibility, and system utility should be addressed.

A plan (acquisition strategy) should be prepared to carry out the proposed development if it meets the above feasibility tests.

C. SYSTEM DEFINITION PHASE

During this phase studies are carried out to translate the operational requirements into system requirements or "design-to" specifications (how the system should be configured). Entry into this phase is based on a decision to further develop and confirm a proposed concept. Preliminary design is carried out, including qualitative and quantitative performance, reliability, maintainability, and other system requirements as well as physical specifications based on the economic and technical feasibility of accomplishing the programme in a stated period of time. During this phase,

prototype hardware for subsystems may be produced to evaluate technological feasibility and reduce development risk. The results of this phase provide the basis for a major decision to continue with full-scale development of the proposed system.

D. DEVELOPMENT PHASE

The development phase translates general system design requirements into a detailed design of the system including preproduction or prototype models. The model is used to evaluate the system's ability to meet the design and operational requirements by means of test and evaluation. During the development of a system, engineering design parameters such as performance, reliability, maintainability and supportability should be integrated by a series of trade-offs to achieve the best possible combination of system cost, schedule and capability. The results of development and initial operational tests provide the basis for a decision to enter the production phase, either pilot or full-scale.

E. PRODUCTION PHASE

The production phase represents a major committment of resources to procure systems in sufficient quantities to meet the required capability. During this phase, emphasis is shifted from engineering design to product assurance to ensure that the production models are capable of meeting the performance specifications. Follow-on operational test

and evaluation of the early production models may result in some design improvements but, in a properly executed design,major changes should not be expected. Logistic support resources must be procured concurrently with the new systems to permit their entry into the next phase.

F. OPERATIONS AND SUPPORT PHASE

During this phase the systems are utilized to fulfill the need. Service use of the systems in the actual operational and physical environment will permit the evaluation of their cost-effectiveness including logistic support planning.

G. MODIFICATION AND RETIREMENT PHASES

Operational employment may also develop the need for modifications or improvements in the capability that are required in order to meet the changing threat. If this is so, the system enters the modification phase. Finally, when the system is obsolescent and must be replaced, iteration of the system life cycle will determine whether a new capability is required or if further modifications will be cost-effective in meeting the current needs and operational requirements.

III. ACQUISITION INITIATION

In this chapter the methods by which an acquisition is initiated in Britain and the United States will be detailed and the differences in the two methods explained. As might be expected, much of the process in the two countries is the same but there are significant variations due to the differences in the organisation of the defence agencies, the size of industry and its relationship with its own defence agency. In order to explain the acquisition initiation sequence a section below is devoted to each relevant part.

A. THE USER-PRODUCER RELATIONSHIP

Before describing the documents of each country that officially initiate the acquisition sequence, it is necessary to briefly describe the organisations of the respective defence agencies appertaining to this sequence. In the heading to this section, the term 'user' refers to the operator or customer and the term 'producer' refers to the organisations responsible for acquisition or procurement.

It is interesting to note that both defence agencies have made fundamental changes to their organisations within a few years of one another and each has taken up the position that the other one has relinquished. In the United States, the producer organisation, under the Chief of Naval Material,

was in parallel with the user organisation, under the Chief of Naval Operations, for two years. Then in 1966, it reverted to its original position of being subservient to it. (Ref. 12) A few years later, in Britain, the producer organisation, under the Controller of the Navy,* was changed from being subservient to the user organisation, under the Chief of Naval Staff, to being in parallel with it. (Ref. 10) The present position is shown in Figure 3 for comparison. In Britain, while the producer is in a parallel path to the user, when it comes to procurement matters he is in a stronger position. This is seen by the fact that the Vice Chief of Naval Staff is the only user on the Naval Projects Committee which is chaired by the Controller of the Navy. (The position of this committee is shown in Figure 7).

Although in Britain, the producer organisation has more official influence on acquisition matters than the user, the effect is balanced by an active user-producer dialogue which is encouraged at a very early stage of the acquisition process. This is shown in the following quote:

> "There is no intention to interfere with the free interchange of facts and opinions between members of the Naval Staff and of the Weapons Department Directorates. The importance of a continuing dialogue between the "customer" and the development and production authorities, in the preparation of the first draft Target or Requirement and at all subsequent stages is fully recognized. (Ref. 13)

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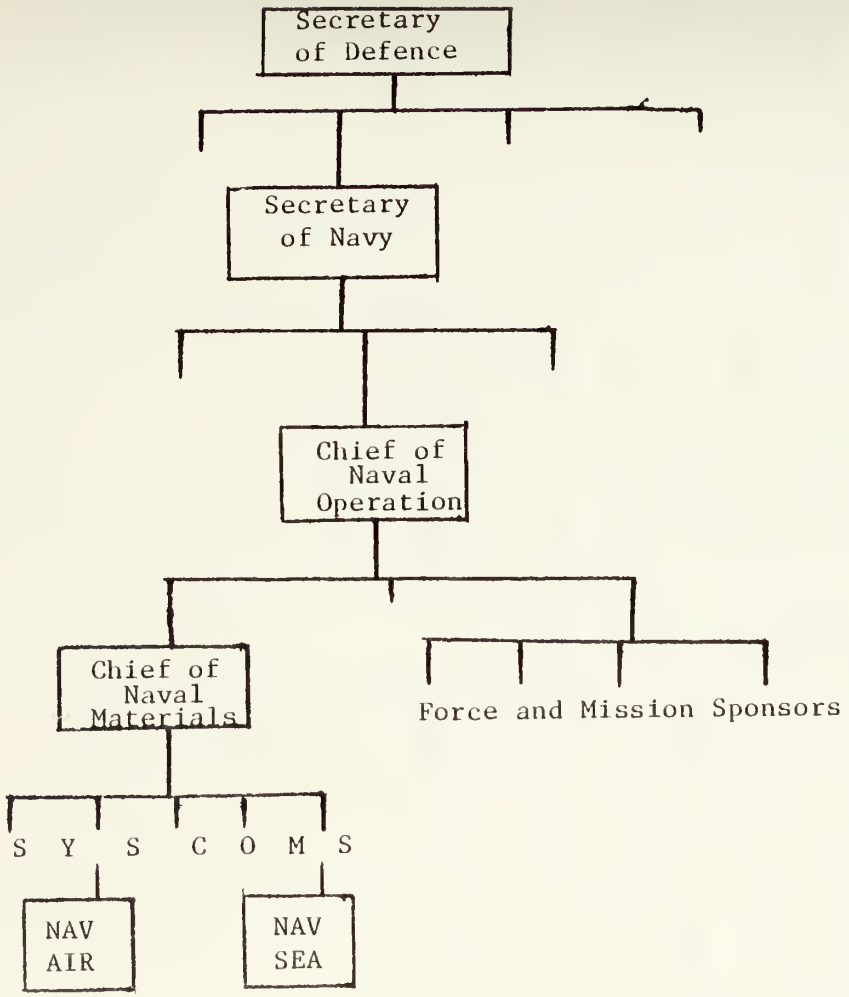
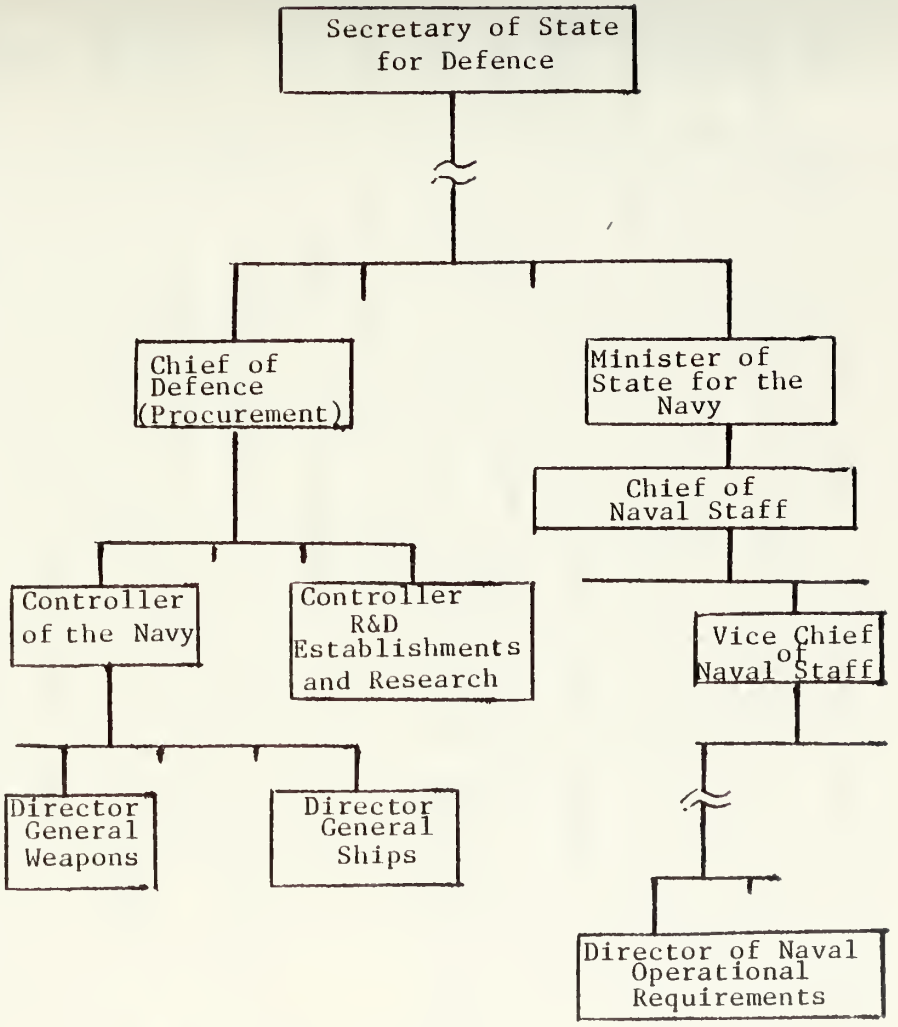
*The Controller of the Navy is the head of naval acquisition and is not the equivalent of a "Comptroller" in the United States, who is concerned with budget and financial matters only.



UNITED STATES NAVY



ROYAL NAVY

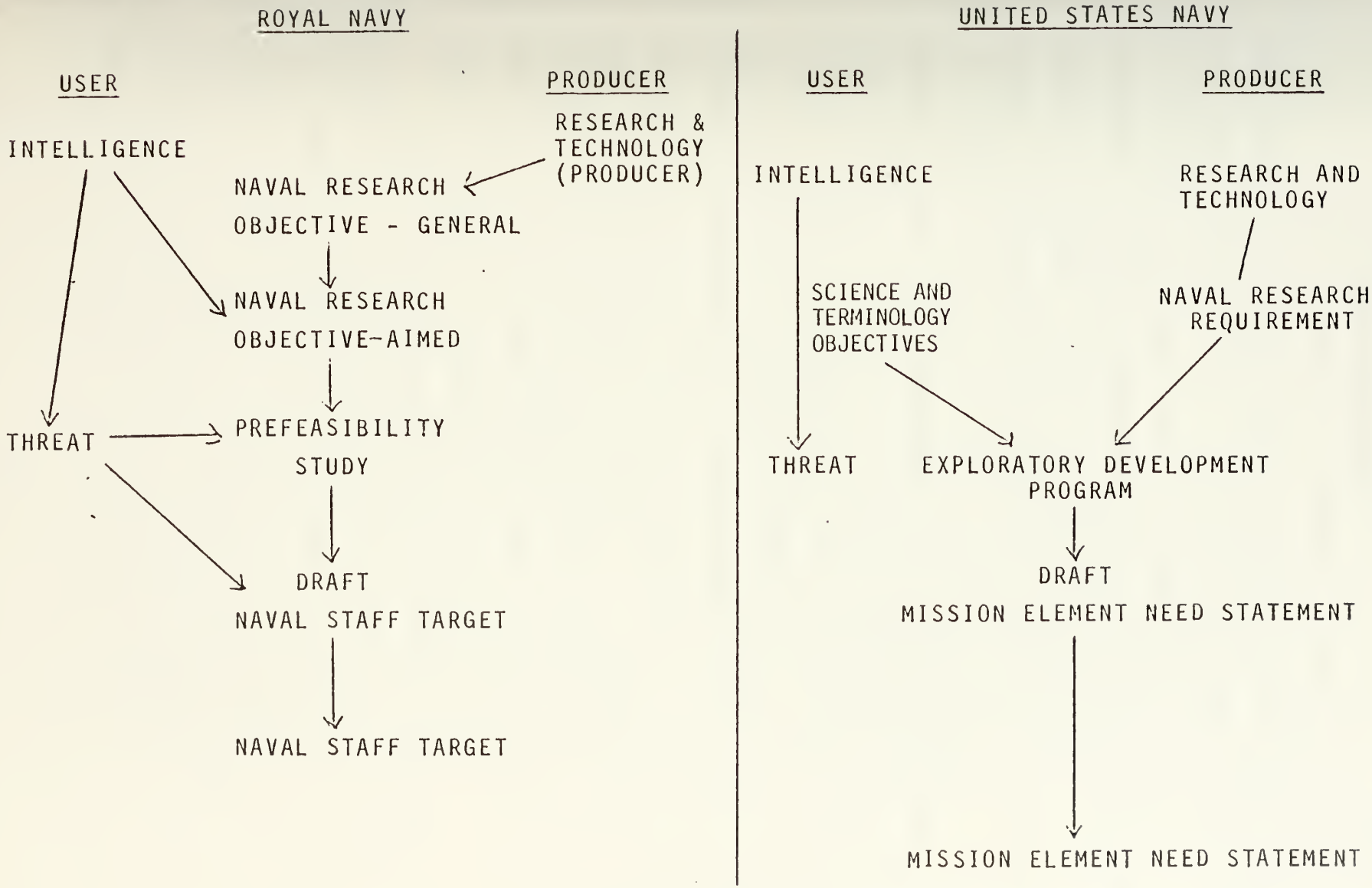
THE USER/PRODUCER RELATIONSHIP

Figure 3

The 'Target' in the quote is the equivalent of the United States Mission Element Need Statement (both described in Section III B 4). Therefore, it can be seen that in Britain the user-producer dialogue starts before the acquisition is officially initiated, whereas in the United States the Mission Element Need Statement is written by the user and a user-producer dialogue typically starts after it has been approved.

B. THE PRESCRIPTIVE SEQUENCE

This is the sequence laid down in the regulations and policies of the respective defence agencies. For the Royal Navy the principle document is the 'NAVSTARCODE' (Ref. 7) and for the United States Navy the leading document is DOD Directive 5000.1 (Ref. 2). In addition to this document, for the United States Navy, there are many supplementary ones which lay down in detail the process that is to be followed and the paperwork that needs to be compiled. For the Royal Navy, the NAVSTARCODE (Ref. 7) is written as an informative guide, and supplementary documents with the detailed instructions do not appear to be so readily traceable. Figure 4 presents a comparison of the process.



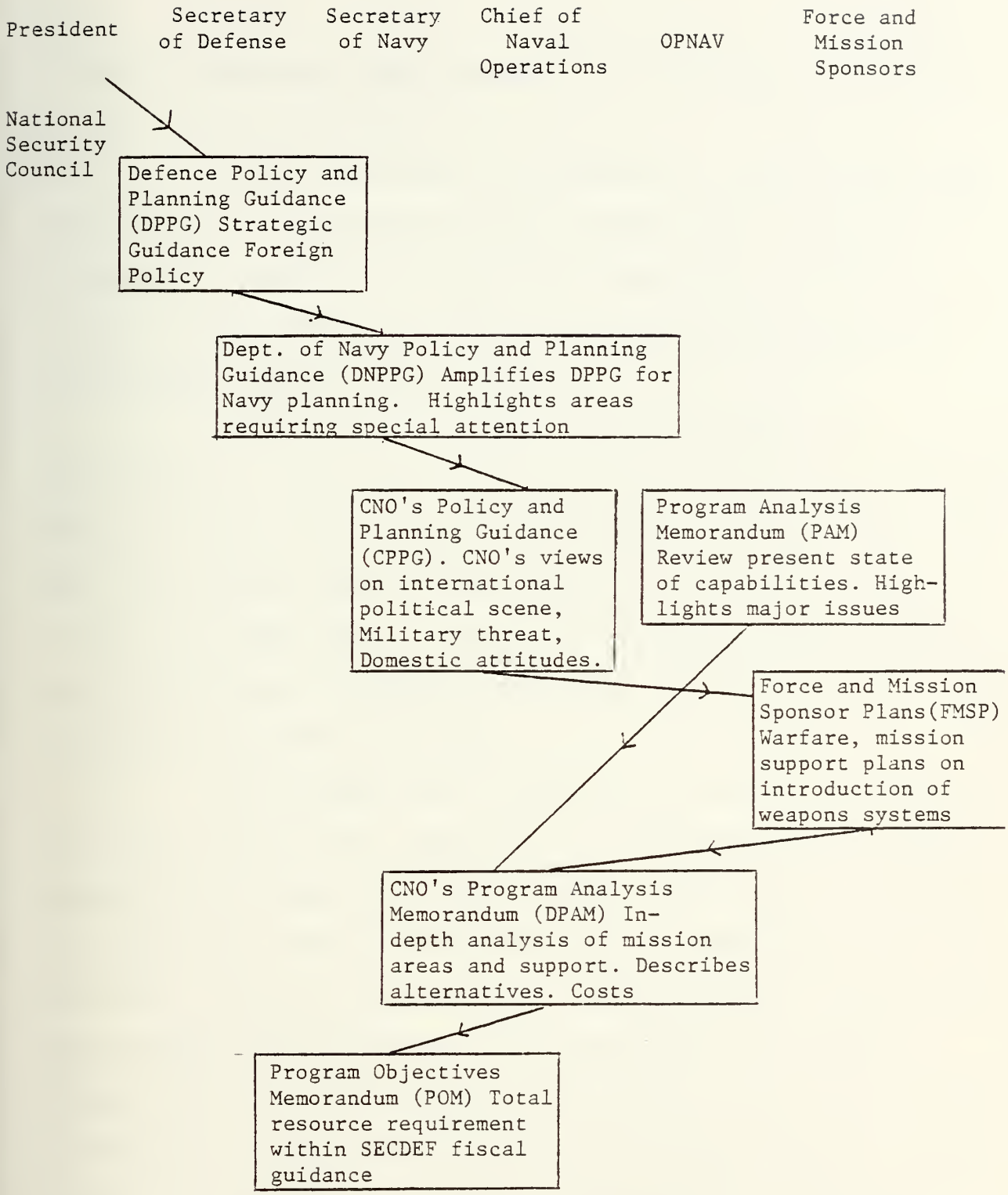
ACQUISITION INITIATION SEQUENCES

Figure 4

1. The Threat Assessment

The existence of a threat is normally reported to the respective defence agencies through intelligence networks, the organisation of which is outside the scope of this thesis. Within the defence agencies, this threat must then be assessed so that any necessary action to counter the threat may be initiated. Within the United States, there is a clearly defined flow of information from the President and his National Security Council through the Department of Defense to the Navy Department. A simplified diagram of this flow is shown in Figure 5. Two very important documents within the Navy Department are the Chief of Naval Operations Policy and Planning Guidance (CPPG) and the Chief of Naval Operations Program Analysis Memorandum (CPAM). The former describes the Navy's roles and missions and furnishes broad Navy planning guidance, a section of it presents CNO's views on the military threat. The latter document provides in-depth analysis of each major mission area and the alternatives on how to accomplish the goals of the CPPG (Ref. 8).

Within the British Ministry of Defence there does not appear to be such a long and detailed flow of information. The overall assessment of the threat in relation to defence policy is debated by the Operational Requirements Committee (ORC) which is chaired by the Deputy Chief of Defence Staff (Operational Requirements). From this committee, broad policies are passed to the Fleet Requirements



THE PLANNING SEQUENCE FOR THE U.S. NAVY

Figure 5

Committee where the detailed composition and characteristics of the fleet are planned.

At this high-level of planning, it can be said that there is a very much more formal system of dissemination of plans and information in the United States than in Britain. In the British Ministry of Defence this function is carried out by more informal policy papers.

In the case of Seawolf, the acquisition was initiated as a result of intelligence as to the expected threat from the late 1970's onwards, and of defence policy which laid down the area of operation and type of ship that it was to be fitted in. Since then a threat of improved electronic counter-measures has been realised, as a result of which an improvement programme has been initiated.

For the SM-2, the initiation is slightly obscured as the SM-2 missile first appeared in a requirement for a more encompassing system, the Aegis system. This latter system was initiated as a result of the Worthington Committee Report in 1965 (Ref. 9) which realised the projected threat through the time frame 1975-1995 of the increased stand-off range of launch platforms with increased ECM capabilities and improved missile and aircraft performance. In a similar manner to the Seawolf improvement programme, an improvement programme for the SM-2 system has been initiated due to the Russian Backfire bomber with Anti-Ship Missile threat being identified as the most stringent fleet air defence threat at present.

2. Advances in Technology

As a general statement it can be said that in Britain, industry is used to a greater extent than in the United States for carrying out defence oriented research. The Rayner Report of 1971 (Ref. 10) emphasizes this by stating:

> "The bias in changing the existing situation should, therefore, be firmly towards reducing the totality of intra-mural research and development effort and increasing that in manufacturers."

This process is still continuing. Within the United States there is now a move towards giving industry more research as stated in DOD Directive 5000.1 of January 1977 (Ref. 2):

> "This technology base shall be maintained by the DOD Components and performed by industry, universities and Government in-house organisations with the major emphasis on industry and universities."

This move is not without controversy as the Government laboratories see themselves being displaced.

Within the British Ministry of Defence there are Defence Research Programmes which can be defined as effort directed towards increasing scientific and engineering knowledge. Each programme (there are a total of three) is broken down into a Naval Research Objective-General and a Naval Research Object-Aimed. The former is for research on a broad front and is generally carried out and paid for by industry. The latter is paid for by the Ministry of Defence and is carried out either by industry or within the Ministry of Defence. All the programmes are reviewed annually by the Defence Research Committee which is a central staff committee designed to link the Secretary of the State for Defence and Chiefs of Staff

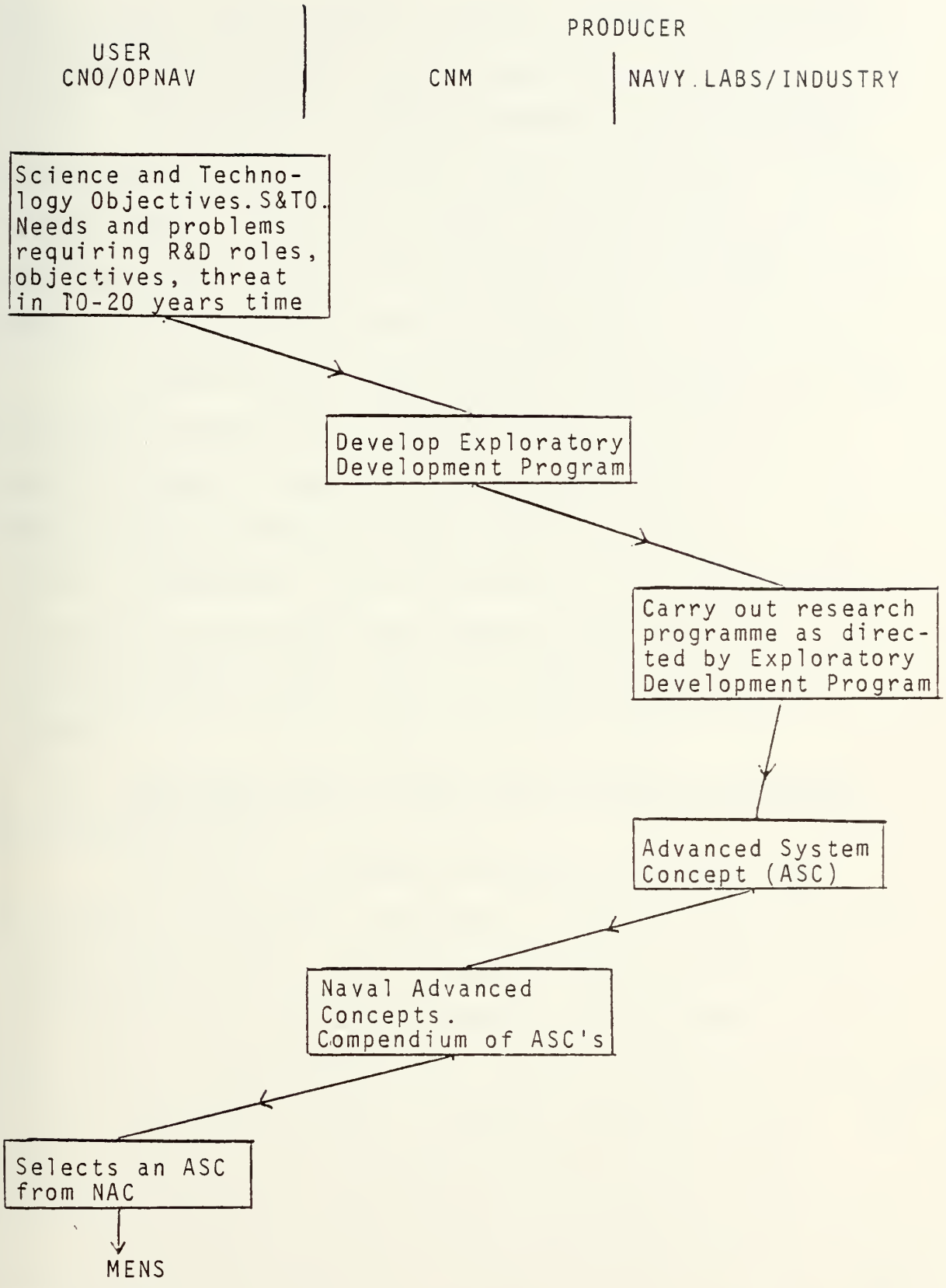
with the defence research community. From discussions with two contractors whose majority of work is defence oriented, one stated that approximately 50% of R&D was funded by the company and the other stated that nearly all was.

Within the United States Department of the Navy, the main document is the Science and Technology Objectives (S&TO). It is controlled by the Director, Research, Development, Test and Evaluation (DRDT&E) who is within the Office of the Chief of Naval Operations and it describes the Navy's problems requiring R&D solutions and also highlights the anticipated threat. As such it does not appear to control how and where R&D funds are spent. If more funds are spent on R&D in industry it is quite likely that these activities will be more closely controlled as they come more under the public eye.

3. Pre-Feasibility Studies (UK) and Technology Base (US)

These may be considered as areas of naval research which are more closely defined and are associated with a particular concept or need.

Within the United States there is a laid down sequence as described in NAVMATINST 5000.22A (Ref. 11) and illustrated in Figure 6. In response to Science and Technology Objectives, an Exploratory Development Program is developed which will be based on a set of dynamic technical strategies designed to: (1) take maximum advantage of new technical opportunities; (2) exploit deficiencies in opposition



RESEARCH AND EXPLORATORY DEVELOPMENT SEQUENCE FOR THE U.S. NAVY (THE TECHNOLOGY BASE)

Figure 6

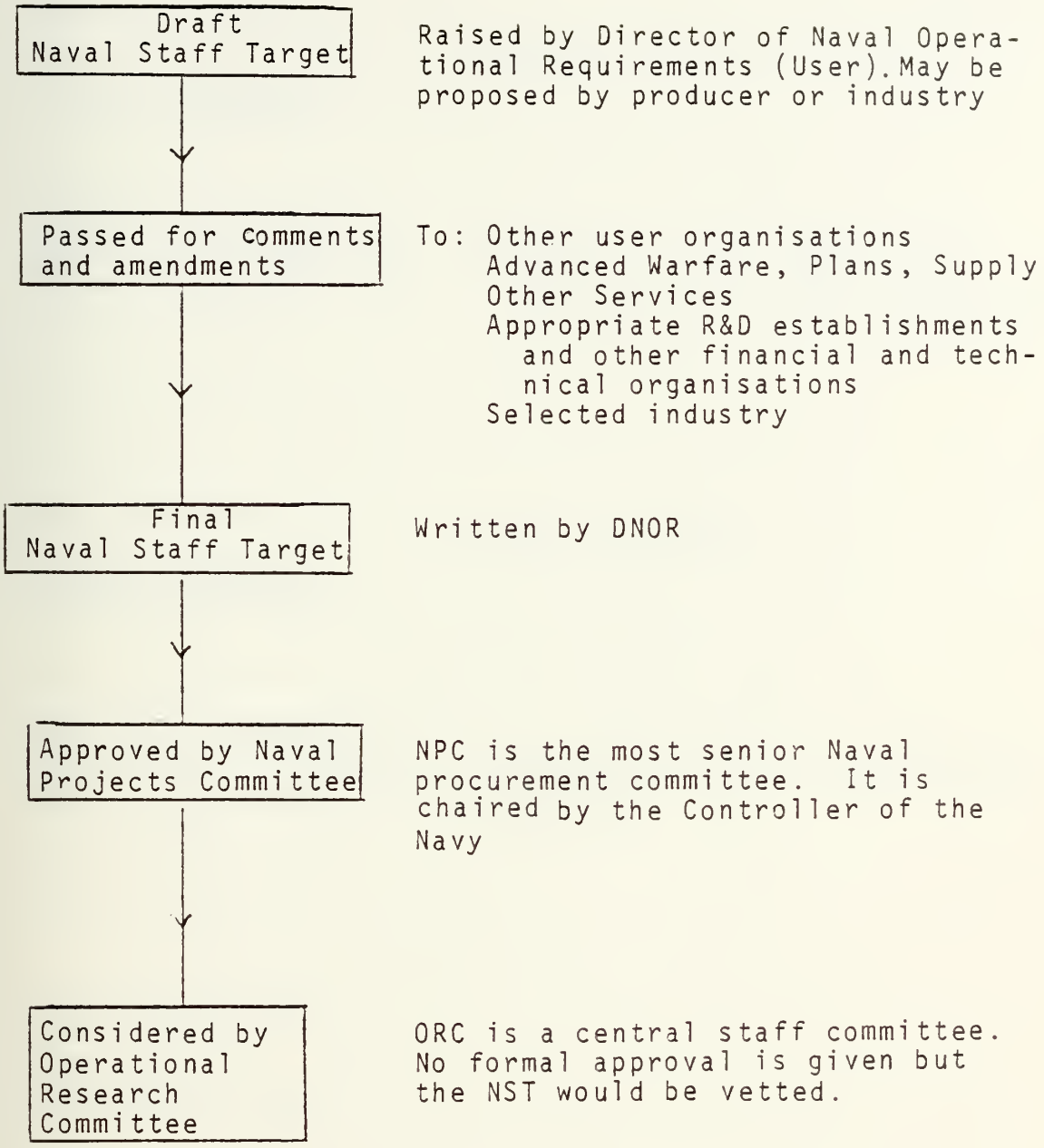
capabilities; and (3) provide prompt response to perceived requirements for superior naval capability. (Ref. 11)

As results of this programme, papers on Advanced System Concepts are written and compiled into Naval Advanced Concepts (NAC). This NAC is then presented to the Chief of Naval Operations annually as a compendium of concepts recommended for further development as required.

Within Britain the process is so defined that pre-feasibility studies are generally only carried out for a specific purpose. They may be either intramural or with industry and if with the latter, would be paid for by the Ministry of Defence. The initiation of the Seawolf project was unusual as the R&D establishment responsible for it went to industry with certain ideas and asked if these were possible.

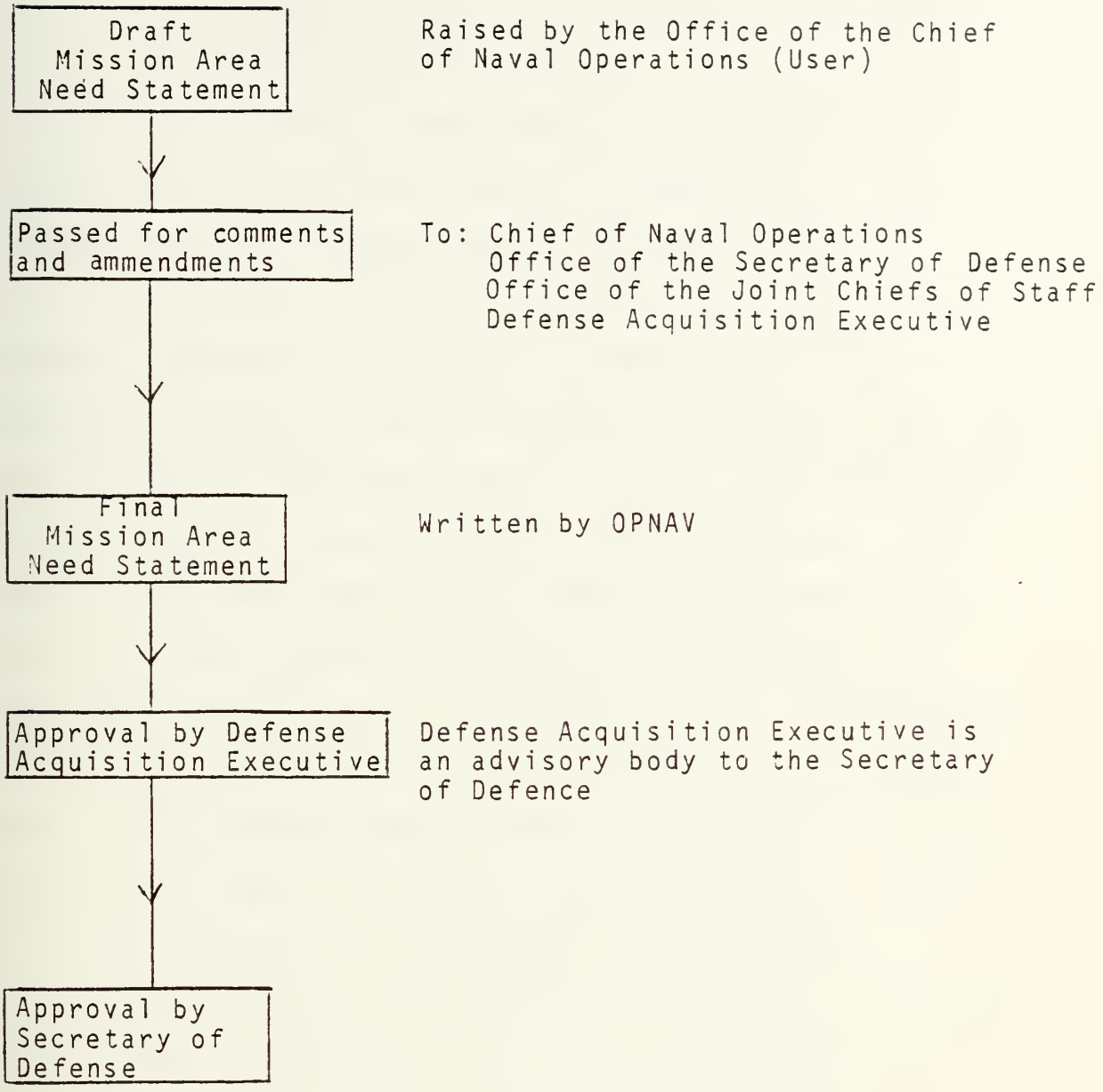
4. The Naval Staff Target (UK) and Mission Element-Need Statement (US)

Approval of the above documents signifies the initiation of a project, the former is British and the latter of the United States. Both documents are initiated by the user organisations and after comments and amendments by other organisations are presented to a central authority for approval. The main sequence of events is shown in Figures 7 and 8. The main differences are that in the British system a user-producer dialogue and participation by industry (Ref. 14) is started during the drafting of the NST, whereas in the United States system it is not. The other main difference is that in the United States system final approval comes from the



THE NAVAL STAFF TARGET PROCESSING

Figure 7



THE MISSION ELEMENT NEED STATEMENT PROCESSING

Figure 8

Secretary of Defence whereas in the British system approval is given by a central staff committee. It is interesting to note that in Britain more emphasis is given to decisions and approval by committee whereas in America it is more by a named individual, though obviously backed by advisors.

In both the NST and MENS the need for the proposed system is required to be clearly stated and is to be expressed in terms of mission purpose, capability, etc. and not in terms of equipments (Ref. 3 and 7). The requirement to have a MENS approved has only been in existence since January 1977 when DOD Directive 5000.1 was issued. (Ref. 2) One of its main objectives is to ensure that there is a clear need before any work is started and it is interesting to note that the Advanced Naval Gun System which started with no well defined mission need and expressed in equipment terms, i.e., a gun, had little support for the six years of its life. It was eventually cancelled by Congress.

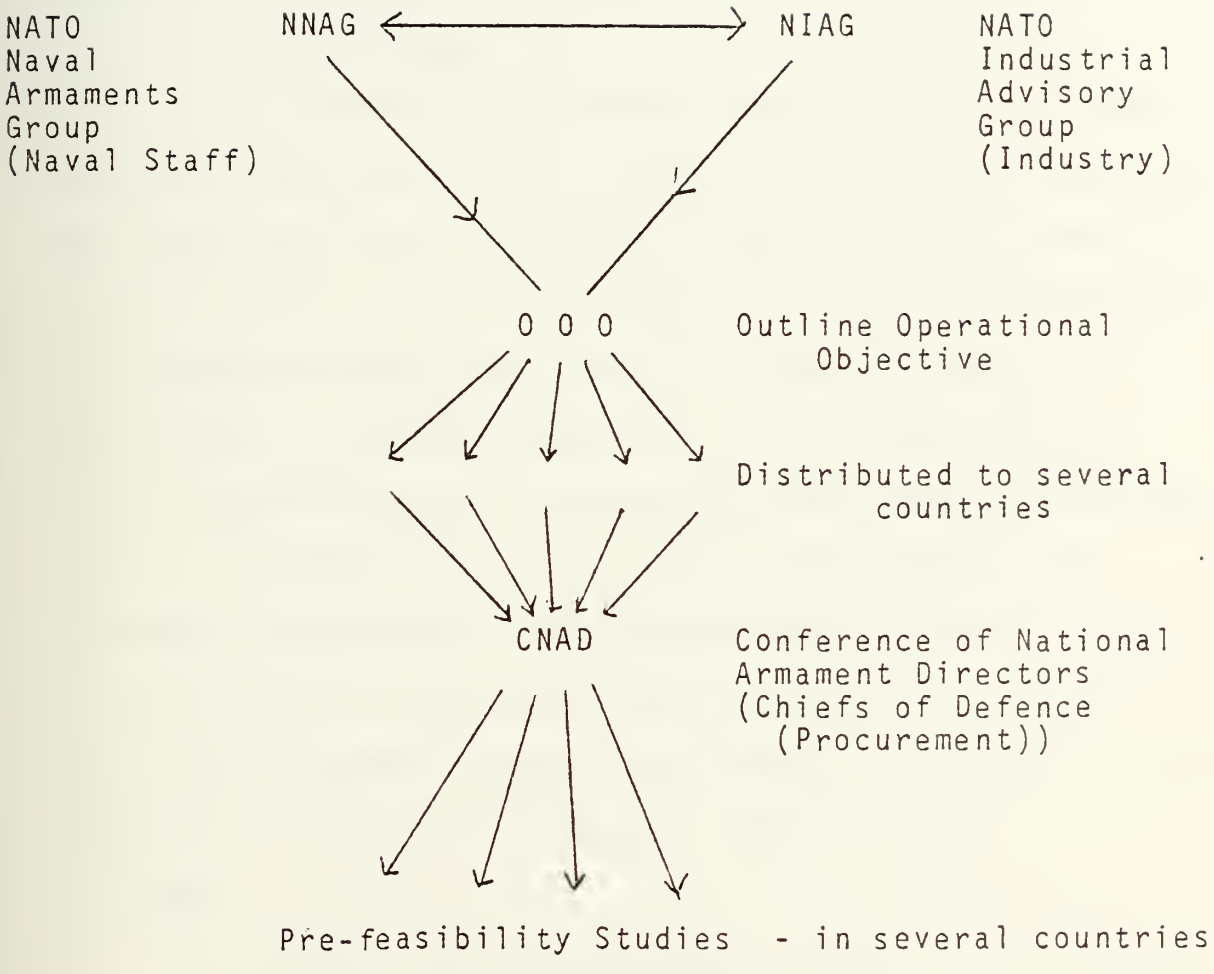
As a final point, in Britain NST's may be proposed by a producer as well as a user and it appears that the producer is more inclined to propose an offensive system while the user proposes more defensive ones. This can be seen by the fact that the user is more aware of the threat to him while the producer is more aware of advances in technology that permit a new dimension of warfare to be achieved.

C. ADDITIONAL FACTORS DUE TO NATO CONSIDERATIONS

1. The Organisation

There are many ways in which several nations can become involved in acquiring weapons from another nation. It can be by purchase, co-production or co-development. For co-development projects, the basic organisation and flow of information are given in Figure 9. In order to complete the picture of aspects due to NATO, some of the problems of purchase or co-production are presented in this section.

For the NATO countries which have their own arms industries but which cannot afford to develop all their own equipment, co-development is the best option. This group of countries includes Britain, West Germany, Italy and the Netherlands but not the United States as it is big enough to develop all its own equipment. The advantages of co-development are: decreased unit costs due to large production runs; sharing of development costs; standardisation and simplified logistics within NATO; and the dissemination of technical expertise among the countries. For the United States though, these advantages are not appreciable and the dissemination of technical expertise is a significant disadvantage to it. Therefore it is not surprising that very much more emphasis is given to co-development projects in Britain and the others of her group than is in the United States. However, it is considered



NATO COOPERATIVE ORGANISATION

Figure 9

by the author that the United States should not ignore co-development projects. This is because if the wealthy middle eastern countries turn from purchasing to co-development, they may well come to countries that are experienced in it rather than the United States. If this were to happen the defence industry of the United States would have difficulty in satisfying its capacity.

2. The Problems

The problem of co-development is that with many countries and more levels of committees and reports, delays are inevitable and it has been estimated that it takes an extra two years to reach a production state. There is also the problem of national pride as to which country will be the leader. Often the compromise is for there to be a joint leadership with its attendant committees, delays and costs. The other main problems are the language and technical conventions. Even between Britain and the United States there are these problems, as experienced on the Harrier and Harpoon projects for example. Therefore between countries of differing languages these problems could be extreme.

If NATO countries become involved in co-production or purchase projects there are problems of balance of payments and support of their own industries. Each country will attempt to support its own industries despite the law being unwritten, but in the United States it is clearly

written that there must be at least a 6% price advantage by buying abroad, or that a similar item cannot be obtained within the United States. (Ref. 15). However, a change of thinking by the United States on this restriction is apparent.

D. OTHER INPUTS CAUSING INITIATION

In order to include all the inputs that can cause the acquisition to be initiated it is necessary to devote this last section to those inputs that do not follow the prescriptive process.

Within Britain, industry has an input which makes a significant impact on what is acquired. It is very difficult to find out how many suggestions or ideas industry presents to the Ministry of Defence as all companies vary in this respect but, as an example, the Guided Weapons Division of British Aircraft Corporation (now British Aerospace) estimate that they make three times as many suggestions to the Ministry of Defence to every one Ministry generated idea. A reason that industry generates its own ideas is connected with foreign sales. When a company considers it can develop a weapon system with foreign sales potential, it is normally only financially feasible if much of the development is paid for by the Ministry of Defence. Therefore it is necessary to present the concept to the Ministry and to negotiate a compromise that will fulfill the needs of the Ministry of Defence and be attractive for foreign sales. As an example, at the present time, the British Aircraft Corporation is suggesting the need for a simplified, light-

weight version of Seawolf. For the Royal Navy it would mean that it could be fitted on more ships and, more important to BAC, it would have good foreign sales potential.

In this chapter the processes by which the Naval Staff Targets (UK) and Mission Element Need Statements (US) are initiated and approved have been discussed. Their approval officially initiates the acquisition phases which are the subject of the following chapter.

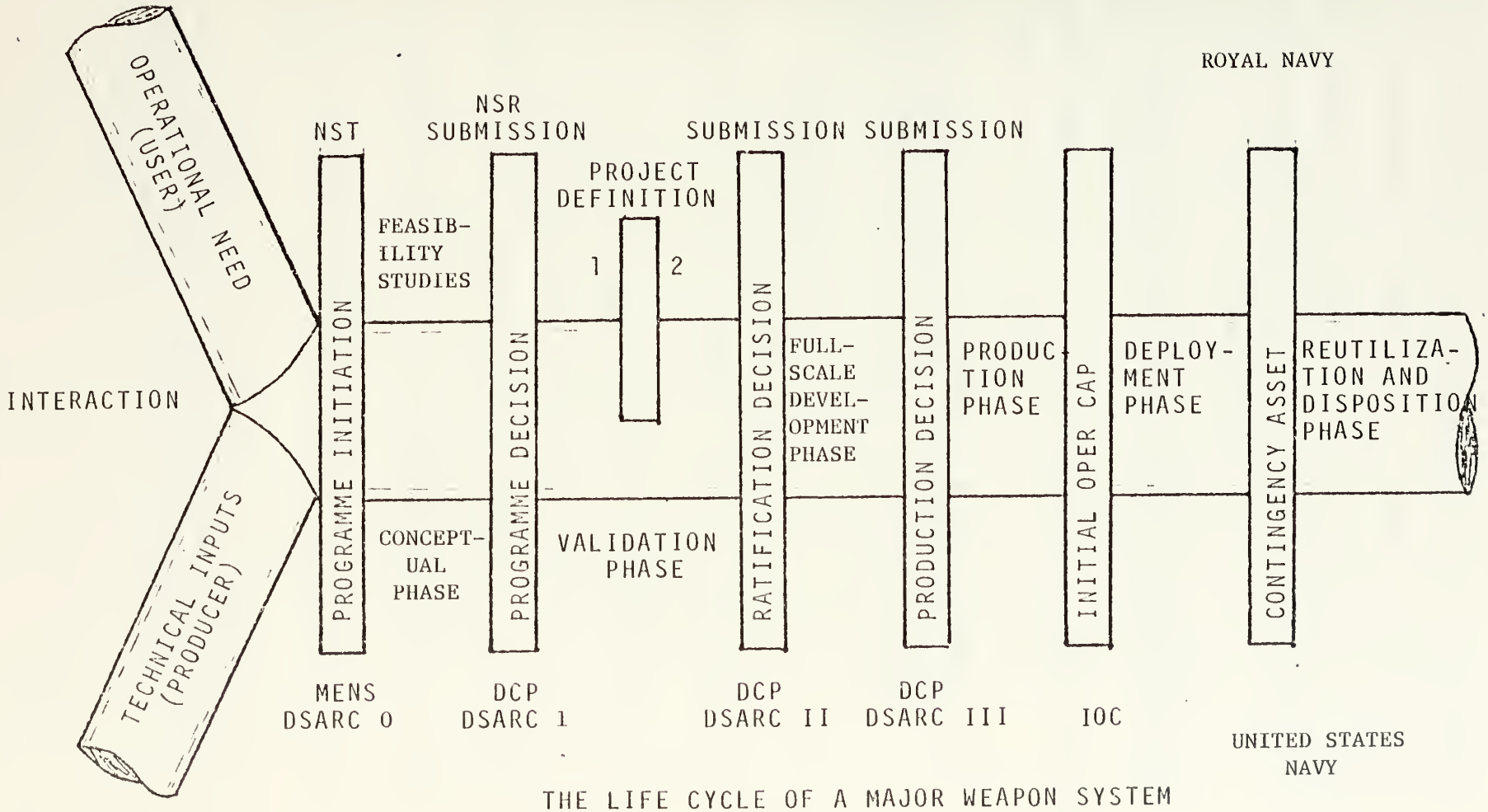
IV. THE PLANNING AND DEVELOPMENT PHASES

In this chapter, the sequence between the official initiation, which was described in the last chapter, and the decision to enter the production phase is described. Within the planning and development phases, the process of: design; evaluation; and decision making are carried out several times. At each iteration as the process progresses, the risk of failure decreases but at the same time the cost of failure increases. Therefore decisions taken to continue the project after it has been in existence for some time must still be rational ones and not treated as the rubber-stamping of a process that cannot be stopped.

In the sections below, the prescriptive sequence will be described with the greatest detail being applied to the earlier phases. Later on in this chapter the differences between contractual practices are presented for comparison. Finally, the problems of ensuring continuity of the project due to fluctuations of the funds available will be highlighted.

A. THE PRESCRIPTIVE SEQUENCE

Within the Royal Navy and the United States Navy a sequence is laid down in similar documents as for the acquisition initiation. Therefore the comments in Section III B apply equally here. Figure 10 shows the basic sequence and it can be seen that the process is very nearly



THE LIFE CYCLE OF A MAJOR WEAPON SYSTEM

Figure 10

the same although with different titles and the fact that in Britain the validation phase is carried out in two parts.

As a general statement about the proportion of effort that should be applied to each stage of development, the Rayner Report (Ref. 10) recommends:

> 'that 15% of forecast development expenditure is incurred before the decision is taken to go to full development.'

The Rayner Report (Ref. 10) also states that the proportion spent before full development:

> 'still falls well short in most cases of the recommended proportions. Evidence here, and in the United States, points to this as a major defect of current practice in both countries.'

1. The Project Team

In both Britain and the United States it is clearly laid down that a Project Manager must be appointed, and the nucleus of a team formed, as soon as the project has been officially initiated (Ref. 5 and 2). In both defence agencies there is concern about the high turn-over of project staff and in Britain the Downey Report especially recommended that:

> in particular, the length of the tours of duty of senior officers in key posts should be extended (Ref. 5).

Within the United States Department of Defense it is laid down that:

> A change in program managers shall not be made prior to Milestone I or during full-scale engineering development prior to the Milestone III decision, except by specific action of the Component Head or his designee. (Ref. 2)

In other words, once a project manager is appointed he should only change during the validation or production phases.

As guidance to the project manager, in the United States there is the Department of the Navy Programming Manual (Ref. 16) and in Britain for the Royal Navy there will be the Guidance Handbook for Project Management (Ref. 17) (at present only in draft form). The former is a very comprehensive book that details much of the Planning, Programming and Budgeting System (PPBS) of the United States as well as the overall acquisition system. It does not go into the details of the day to day running of a project. On the other hand, the British Guidance Handbook concentrates on the running of the project to the exclusion of much of the detail of overall planning and budgeting.

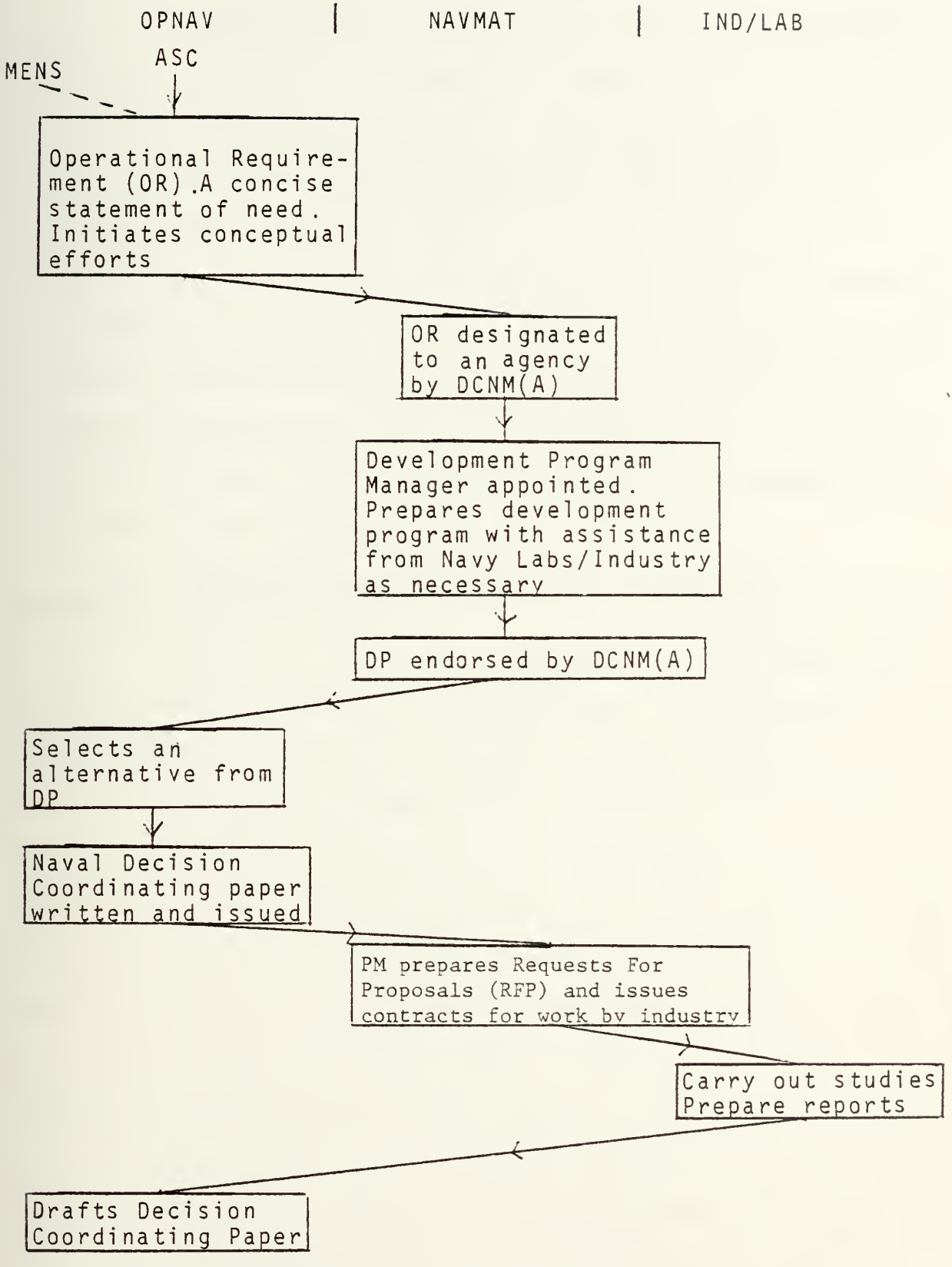
2. Feasibility Studies (UK) and Conceptual Phase (US)

This phase is the process of converting the Naval Staff Target (UK) or Mission Element Need Statement (US) into an operational requirement based on conceptual design approaches that are feasible.

In Britain, the NST is circulated to selected industries, some of whom may have already been involved in the drafting of it. Tenders are then invited for feasibility study contracts with contracts being awarded to a few companies. The number of contracts awarded depends on the size and complexity of the future development programme and on the response from the companies approached. To whom the

contracts are awarded is decided by the project team and contracts department. This decision is based on technical and financial competence and the capability of the contractor to undertake the whole development and production programme. It is not necessarily based on the lowest bidders. As an example, with the Seawolf missile, feasibility study contracts were awarded to three contractors, one of which was the British Aircraft Corporation. The output of the study is a report by the contractor giving a technical appraisal of the viable solution to meet the NST requirements, together with preliminary estimates of development and production costs and time scales for the preferred solution. This report is used as the basis for discussions between the user and the producer which lead to the drafting of the Naval Staff Requirement, which is discussed in the next section.

At present, within the United States, the sequence of events and documents is under review. This has been caused by the recent introduction of the Mission Element Need Statement at the beginning of the process. The MENS was introduced by the Department of Defense in DOD Directives 5000.1 and 5000.2 (Ref. 2 and 3) but as yet the Department of the Navy has not modified the instructions that were extant prior to this. Therefore, at present if all the directives are adhered to, there are too many documents at the beginning of the conceptual phase without enough analyses or technical studies. The situation is displayed in Figure 11 with the MENS (shown dotted) added to the existing sequence of events.



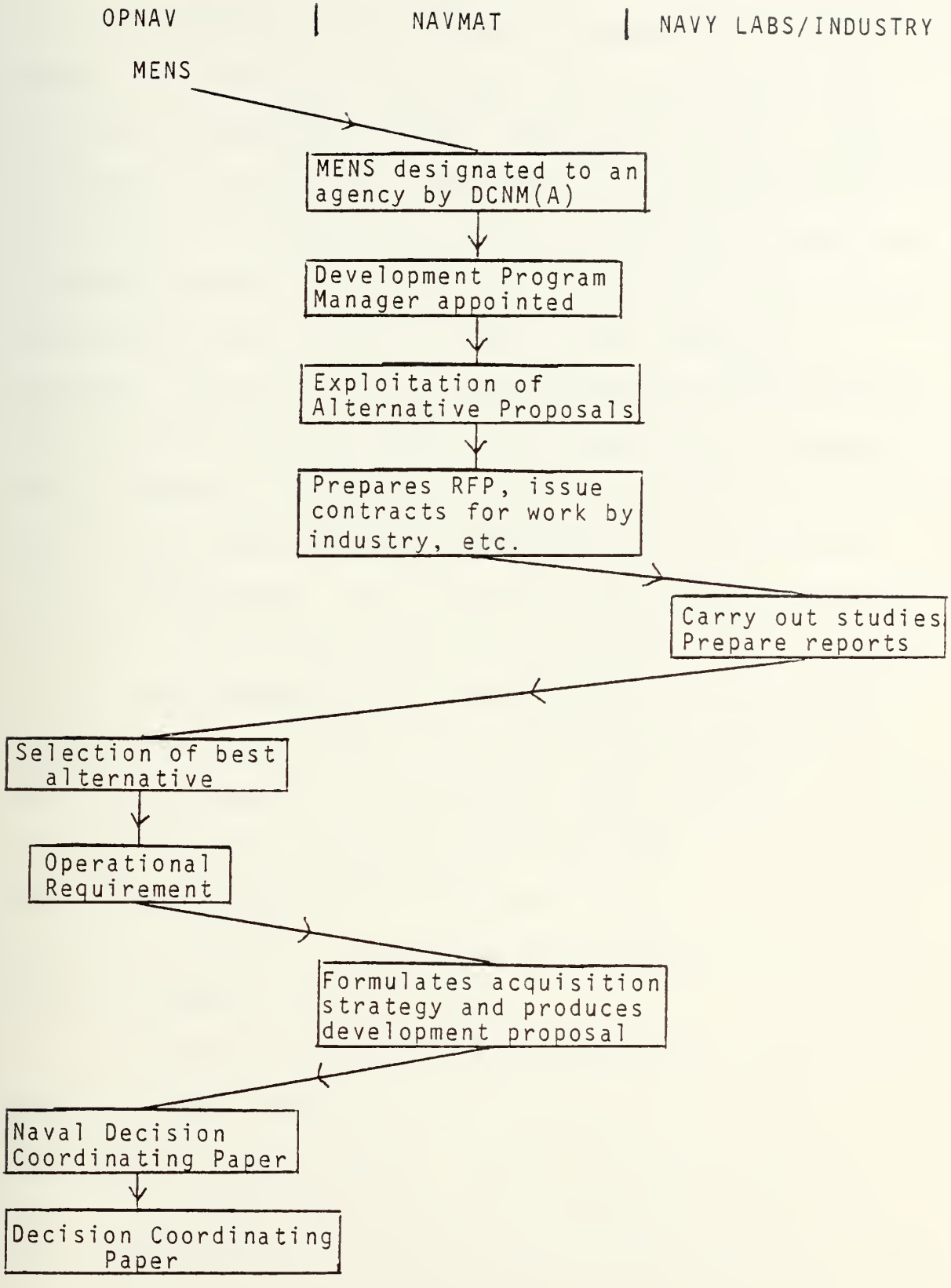
PRESENT CONCEPTUAL PHASE DOCUMENTATION AND REVIEW PROCEDURE

Figure 11

Simplification of this phase is required and one proposal (Ref. 18) is as shown in Figure 12. In this, conceptual studies would be carried out immediately after approval of the MENS and before the Operational Requirements are written. The other main change is that the Navy Decision Coordinating Paper (NDCP) would become the source document to the Decision Coordinating Paper (DCP). When compared to the British sequence during this phase, both the present and proposed United States ones have an additional iteration of decision making. This is for the formulation and approval of the acquisition strategy.

3. Naval Staff Requirement (UK) and Decision Coordinating Paper (US)

These two documents, the former of the Royal Navy and the latter of the United States Navy, are the prime sources of information for decisions on the respective projects and as such require to be approved for continuation of the project. For the Royal Navy, the Naval Staff Requirement (NSR) is approved before the Project Definition phase begins and thereafter forms the requirement specification, termed "Agreed Characteristics", which cannot be altered except by deliberate approval. For the United States Navy, the Decision Coordinating Paper is updated at the beginning of every phase of the project to reflect the increasing detail of the specifications as the design becomes more certain. The specifications become fixed on entering Full-Scale Development.

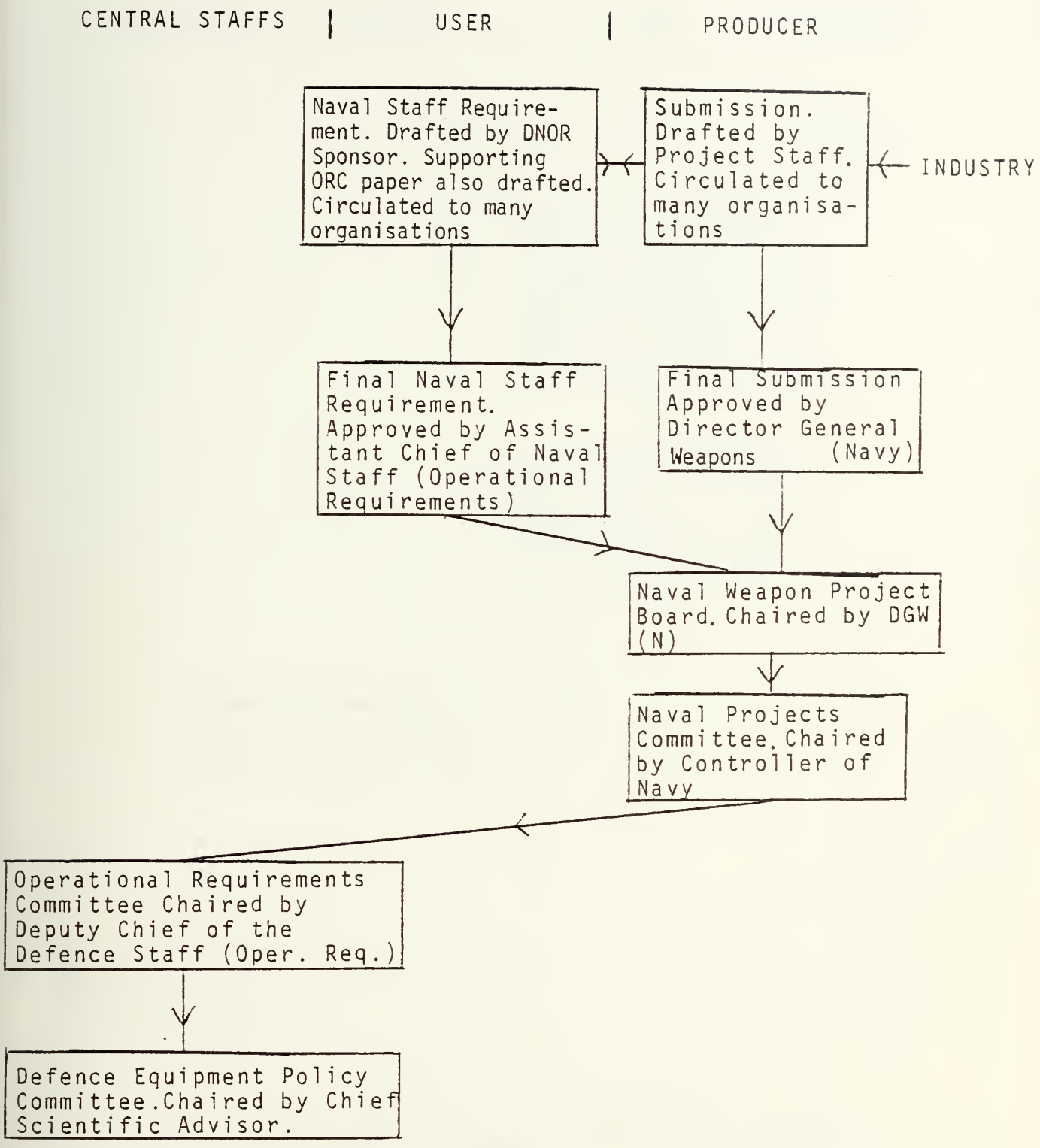


PROPOSED CONCEPTUAL PHASE DOCUMENTATION AND REVIEW PROCEDURE

Figure 12

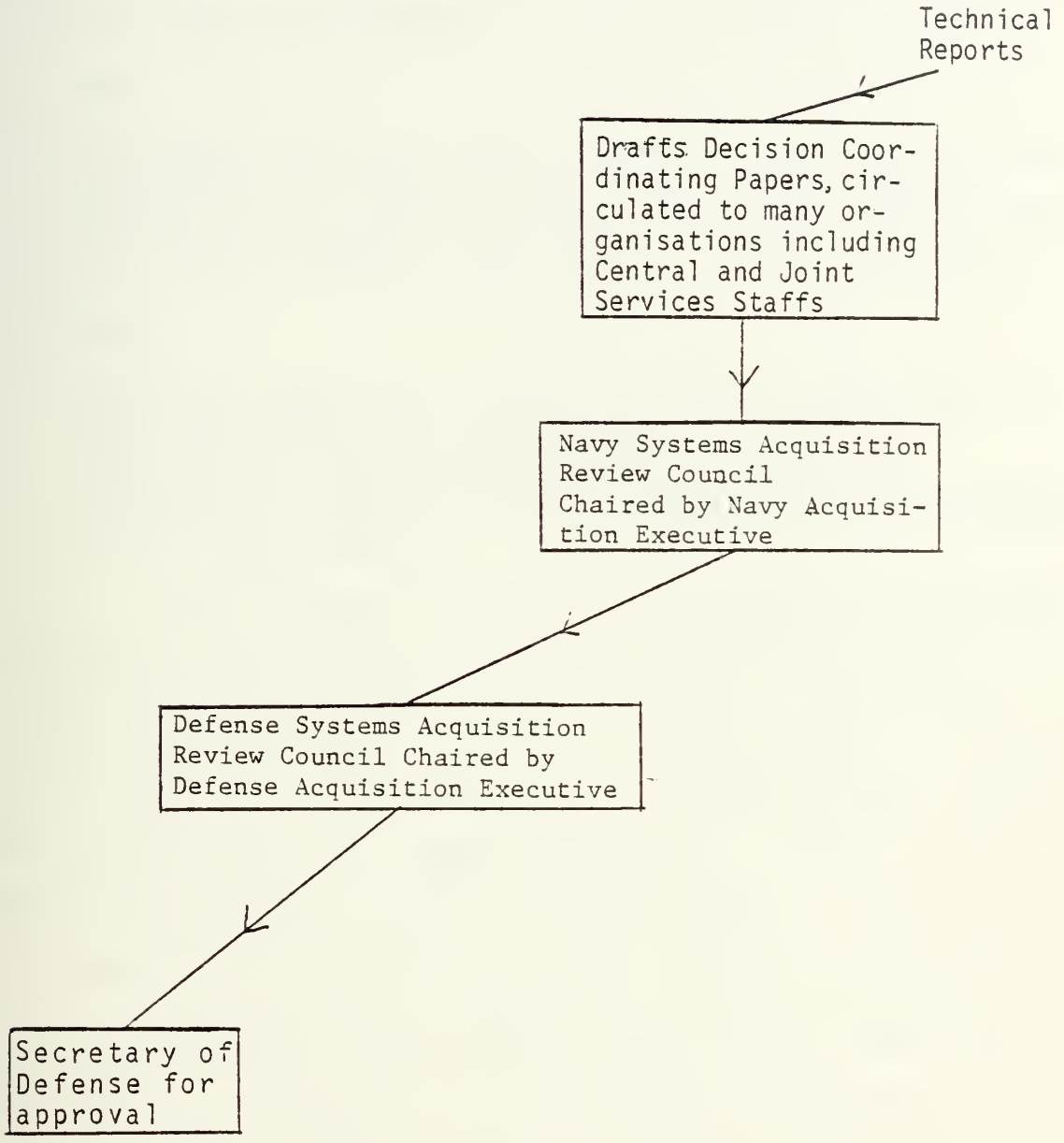
Figures 13 and 14 show the sequence of drafting and approval for each navy. The Naval Staff Requirement paper with the accompanying technical submission is what is formally considered by the various committees, and the Project Manager is only called upon sometimes to answer questions or elaborate on certain topics. For a project in the United States Navy, presentations are required to which great importance is attached. These are given to the System Acquisition Review Councils of the Navy and then of the Department of Defense. The performance by the project team at these presentations is significant to the successful continuation of the project. In the United States, final approval comes from the Secretary of Defense, whereas in Britain the Minister is not involved at this stage, delegating the final approval to the Defence Equipment Policy Committee. It could be considered that the final act of approval by the United States Secretary of Defense is to endorse the recommendation of the DSARC. However, it is interesting to note that in the case of Aegis with SM-2, the Secretary of Defense selected and approved a different option to that recommended by the DSARC.

The Defense System Acquisition Review Council (DSARC) has the responsibility of considering all aspects for continuation of the project. These include that there is still a valid need; the technical assessment and remaining risks; the resources available, both material and financial; the available alternatives; and the overall acquisition strategy (Ref. 3). Within Britain this responsibility is



NAVAL STAFF REQUIREMENT (UK) REVIEW PROCEDURE

Figure 13



DECISION COORDINATING PAPER (US) REVIEW PROCEDURE

Figure 14

divided between the Operational Requirements Committee (ORC) and the Defence Equipment Policy Committee (DEPC) as defined in their 'terms of reference' (areas of responsibility):

ORC

To keep under review the pattern of long term military equipment and weapon requirements, against the background of current Defence policy and longer-term studies in order to make the most effective use of the likely available resources.

DEPC

To advise what major projects should be included in the development programme to meet operational requirements endorsed by the ORC, taking into account of defence budget resources and consideration of national industrial defence potential, collaboration and foreign purchase.

Having been approved by the respective committees, a project cannot continue with the placing of contracts until funds have been released to it. In Britain, this is effected by a request or 'submission' to the Treasury which normally then releases the full amount requested. In the United States, the release of funds can be affected by the opinions of Congress as a whole in the annual Defense Authorization Bill and by the House and Senate Appropriation Committees in particular. In Britain, this oversight by government is carried out by the Parliamentary Select Committee on Expenditure - Defence and External Affairs Sub-Committee which investigates defence matters on a selective basis. In the case of Seawolf, this committee carried out an investigation on more than one occasion.

4. Project Definition (UK) and Validation Phase (US)

This is the phase in which, through extensive analysis and hardware development, the major programme characteristics are determined between the project office and the contractor(s). Detailed estimates of the development cost and of the development plan are also outputs of this phase.

As shown in Figure 10, there is a major difference between Britain and the United States in this phase, as in Britain it is split into two phases called Project Definition 1 and 2 (PD1 and PD2). By the end of PD1, there should be a coarse plan of the work required for full-scale development with an accompanying PERT/TIME network and cost estimates of each task. There should also be an initial estimate of unit production costs. By the end of PD2, there should be the detailed plans, estimates and specifications for full-scale developments. Between PD1 and PD2 the normal process of approval is still carried out although work on PD2 is not delayed pending the approval. During an interview with the Project Manager who was responsible for the Seawolf missile development and who is a proponent of the recommendations of the Downey Report (Ref. 5), he stated that in his opinion, approval at a lower level between PD1 and PD2 would be sufficient. As stated at the beginning of this Chapter, 15% of the total development funds should be spent during the Project Definition phase and in Britain this should be divided as 5% during PD1 and the remaining 10% during PD2. The splitting of the Project Definition phase was a

recommendation of the Downey Report (Ref. 5). Prior to that Full-Scale Development was started at a stage equating to the start of PD2. Therefore, for the Seawolf system, which started development before the Downey Report (Ref. 5) was published, Full-Scale Development started after only 6% of the development funds had been spent. At that time a comprehensive development plan had not been drawn up and it was another 6 to 9 months before Work Package details were finalized (Ref. 19).

By the end of the Project Definition or Validation Phase, the detailed performance specifications should be finalised and there should be a cost and schedule plan. In Britain the cost and schedule are presented in the Development Cost Plan (DCP)* which is fully described in the 'Downey Handbook of Procedures' (Ref. 20). This document is the responsibility of the contractor, but in practice is produced from many discussions with the Project Team on cost and schedule trade-offs. Also in Britain, as in the United States, the contractor is invited to propose draft incentives of a contract for the next stage of development. This proposal, the DCP and a performance specification then form the major parts of the bid for the Full-Scale Development contract.

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*This should not be confused with the United States Decision Coordinating Paper.

5. Full-Scale Development

Before Full-Scale Development can start the process of gaining approval must be completed again. In the United States the Decision Coordinating Paper is updated and submitted along with a presentation to the NSARC and DSARC. Finally the Secretary of Defense approves the start of Full-Scale Development. This process follows very much the same pattern described in Section IV A 3.

In Britain, a similar process is followed as in Section IV A 3 and to the previous paragraph, except that the Naval Staff Requirement is only amended if specifications cannot be met. Therefore, the main input for approval is the 'submission' from the Project Office. In addition to the sequence of approval in Section IV A 3, for Full-Scale Development the approval of the Minister of State for Defence must be obtained.

B. CONTRACTUAL ASPECTS

Here there is a fundamental difference between the United States and Britain. In Britain contracting is carried out under English common law while in the United States there are special laws contained in the Armed Services Procurement Regulations (ASPR) (Ref. 21). These regulations were introduced in 1947 and have been continually changing and becoming more complex ever since. Contractors who deal with the Department of Defense are expected to know these regulations and to conform to them.

It is beyond the scope of this thesis to explain the many differences between the laws applicable to military contracts in the respective countries but a few of the more relevant ones to a project are described below. Although a contract is normally a bilateral agreement, when the Department of Defense is one of the parties certain decisions may be taken unilaterally by the Contracting Officer. One of these concerns a Change Order which the Contracting Officer may force upon a contractor. This means that the contractor is obliged to carry out the order without delay, with an equitable adjustment to the contract price being made later on. In a similar manner a Contracting Officer may instruct a contractor to speed up his schedule. If there are disputes over the terms or costs of the contract and agreement cannot be reached between the contractor and the Contracting Officer, the latter makes the final decision which is binding unless the contractor appeals through the Armed Services Board of Contract Appeals or the Federal courts.

The Contracting Officer referred to in the paragraph above is responsible to the Project Manager and is the only officer authorised by law to make or amend contracts within a project. This is different from Britain, where the Project Manager himself has this authority. In the United States, members of a project team are very carefully instructed not to order a contractor to do additional work

or to in any way imply that they have the authority to do so. When dealing with any contractors, team members often are required to show them a card, called 'The Green Card' with the following statement on:

Statement of Limitation of Authority

You are hereby notified that I do not have the authority to direct you in any way to alter your obligations or change the statement of work in any contract.

Further, if the Navy, as a result of the information obtained from today's discussion, does desire to alter your contract obligations or to change the contract statement of work, changes will be issued in writing and signed by the contracting officer. You should take no action on any change unless and until you receive such a change order.

Competition between firms is very much stronger in the United States than in Britain. In many cases in Britain, this is because there may be only a very few companies that are specialised in a particular field, and that for some of them, their resources may already be fully extended. Within the United States, competition is actively encouraged and OMB Circular A-109 (Ref. 1) has again stressed the point by stating that competition should continue within a project for as long as is economically possible and definitely through the Validation Phase. OMB Circular A-109 (Ref. 1) also states that if a project team wishes to limit the system design to a single contractor, prior approval must be obtained from the Secretary of Defence with the basis of the decision reported to the Congressional Authorisation and Appropriations Committees.

In the case of SM-2 the selection of General Dynamics as the development contractor was by an unusual process.

Before SM-2 was separately identified, the Aegis system had passed through the Validation Phase with competition between Raytheon, RCA, General Dynamics and Boeing. When the development contract was placed for Aegis, it was awarded to RCA, but the missile was excluded from the contract. Soon afterwards, General Dynamics made an unsolicited proposal of a missile which was based on a modified SM-1 missile. This was accepted by the Navy and therefore General Dynamics won the development contract for the missile without competition. For the Seawolf missile, there was some competition but this was limited to the Feasibility Studies by the British Aircraft Corporation, Short Brothers and a group comprising of Hawker Sidley Dynamics, General Electric Co. and Sperry Gyroscope. Project Definition was awarded to the British Aircraft Corporation and development was split initially between eight specialized contractors. One of these contractors was the British Aircraft Corporation which was responsible for the main airframe and, therefore, for the compatibility of the subsystems. However, the other contractors were not subcontractors to BAC as their contracts were directly with the Ministry of Defence.

The situation for Seawolf described in the above paragraph continued for two years, at which point it was decided to implement the new policy of giving the total package to one contractor. In this package the British Aircraft Corporation, as prime contractor, was responsible

for design, development and production of 100 missiles, all other contractors being subcontractors to the prime. Also included in this package was a Target Cost Incentive clause, which was being used for the first time.

When there is a lack of competition, as in Britain, where one buyer, the government, is dealing with one or a few sellers, it is difficult to establish a market price with a reasonable profit margin. Therefore in Britain, the Ministry of Defence has negotiated with the Confederation of British Industry formulae for the calculation of profits on defence contracts. Called the '1975 profit formulae,' there is one for risk contracts and one for non-risk. The details are:

Risk: 10.8% on capital employed + 5.4% on costs

Non-risk: 9.9% on capital employed + 0.7% on costs + 0-4% as efficiency award.

The general principle is that an average contractor should earn 18% profit per year on capital employed. For the Seawolf missile the Target Cost Incentive varies between 1.1 times the risk rate of profit to the basic non-risk rate of profit. In an interview with the man responsible for the Seawolf missile contract, he stated that incentives for schedule and performance were not employed. This was because they would have been very difficult to negotiate originally and would be time-consuming to renegotiate for every contract change. In other words the costs involved would have far outweighed the savings.

In the United States, where the defence industry is very much larger and where there is a choice of potential contractors, competition is available and negotiation for a market price is generally possible. Therefore, it is not necessary for there to be an overall agreement between government and industry as there is in Britain. Also much more emphasis is placed on incentives in contracts. These contracts may be either Cost Plus Incentive Fee or Cost Plus Award Fee and in both cases cost, schedule and performance form criteria for the incentive. In the case of the SM-2 missile the contract is a Cost Plus Award Fee with 5% of target costs a fixed fee and up to 10% of target costs as an award fee. This 10% award is then split as 50% on performance, 40% on schedule and 10% on costs.

Finally, when a contract award is announced in Britain, the price is confidential and is only communicated to those people who have a reason to know. In the United States, the contract price is required by law to be published so that all unsuccessful competitors may know the final price. This is because it is normal to award the contract to the lowest qualified bidder and if the contract is awarded to a company other than the lowest one, the lower bidders have the right to find out why they were not awarded the contract.

C. CONTINUITY OF THE PROJECT

In both Britain and the United States there are delays due to the administrative details in approving the continuation of the project between phases. As a project

advances through the phases, the effects of this delay become more extreme as the project team of the contractor employs more men. This problem is recognised in both countries and attempts are made to speed up the approval process as well as providing funds for the project to continue on a temporary basis. In the United States the most critical time is during the selection of the contractor for Full-Scale Development. During this period approximately three contractors may have teams working on the project and therefore for two of them this work is probably worthless. The Department of Defence aims to complete the Source Selection Process within a few months but in practice the normal time is between six months and a year. During this time the contractors are funded to keep together a small team for further exploratory work but the team is very small and the progress is probably very slow.

In Britain there is a similar situation with delays between phases of six to nine months. However, as normally only on contractor will have carried out the Project Definition Phase, little unnecessary work is carried out. For a similar reason, as money will not be wasted, the proportion of funds released between phases is greater so that a larger team can be kept together. However, work does slow down and as quoted in the Downey Report (Ref. 5):

> As a result, these projects lost momentum and contractors complained that there was a serious deterioration of morale and that, in some cases, key team members were lost.

Finally when funds are provided to a contractor on an interim basis, the contractor will not commit himself to any capital investment or take on personnel with the result that when the contract is signed the project is slow to start.

V. INTERACTIONS BETWEEN DEFENCE AGENCIES AND CONTRACTORS

An interaction is any means by which organisations influence each other; examples include cooperating, transacting, conferring, collaborating and debating (Ref. 22). Also, an interaction is an influence between two parties that must occur in both directions. Therefore, a report is not strictly an interaction as it is only a one way communication. However, in practice, it can be considered as an interaction as there is normally some response to a report.

The object of this chapter is to describe the methods of interaction between the respective defence agencies and industries. In particular, it will highlight the differences of interactions between the project office and the project contractor in each country.

A. OFFICIAL INTERACTIONS

Official interactions in this context are all formal reports and documented meetings that occur on a regular basis. The requirements for these meetings and reports are normally laid down in the contract and they form the prime means of communicating the progress of the project between interested parties.

As a general, overall statement, it can be said that there are very many more reports and meetings between a project office and contractor in Britain than there are in the United States. The reason for this appears to be due to

the greater physical separation of the project office from the contractor in the United States, resulting in meetings being more costly and time consuming. Also, in the United States, there is frequently a 'Technical Representative' and assisting team, who may be part of the project office, resident at the contractor's plant. They are in very close day to day contact with the contractor and therefore this obviates the need for so many detailed progress reports and meetings.

In Britain, guidelines for the frequency of, and those involved in, meetings and reports are described in the Handbook of Procedures (Ref. 20). At the lower level it is recommended that technical progress meetings be held every two weeks to review the latest progress data at Element Level and above. This meeting is primarily an internal contractors meeting but the Ministry Project Manager is invited to attend. However, in practice, it is normal to hold these meetings only monthly. At the upper level it is recommended that there be a quarterly meeting to review expenditure and technical progress. As well as the project team from the Ministry and the contractor attending, the senior management of both parties also attend. In addition to these periodic meetings, there are Configuration Control Meetings, the frequency of which varies depending on the circumstances. These meetings consider changes in requirements and specifications, and design changes that affect costs.

Regular reports are also required to be submitted by the contractor. These would be discussed at the regular meetings and monitored at other times by the Project Office. A chart of the various reports and their distribution to the Ministry of Defence is shown in Figure 15. It is considered by the author that the volume and detail of all these reports would preclude them from being fully read and understood. As described in the Handbook of Procedures (Ref. 20) much of the content of the reports is raw data and there is no method of highlighting large variances or other problems.

If the process in Britain suffers from an over-abundance of meetings and reports, it appears that in the United States the reverse may be true. For nearly all major systems acquisitions the only periodical cost and schedule report required is the Cost Performance Report. It is a monthly report of contractual progress with identification of significant problems obtained through analyses of variances from plans by the contractor. Normally, it is presented at the major task level (Figure 17). In the case of SM-2, there are no regular progress meetings as such, detailed information about the overall progress of the project is reported and discussed during the evaluation of an Award Fee. Cost Plus Award Fee type contracts are relatively new with their use increasing. In a contract of this type, there is a fixed fee of 3-5% of target costs and an award fee of up to approximately 10-12% of target costs. Therefore, as the majority of the contractor's profit is involved in the award, the evaluation of the state and progress of the project is very thorough. The process of awarding a fee is

Schedule Progress Reports	To the Ministry		Within Contractor		
	Project Director	Project Manager	Senior Management	Project Sponsor	Work Sponsor
PERT Output Float Order					
i) Element level		**		**	**
ii) Minor Task Level	*	*	*	*	*
iii) Major Task Level	*		*		
PERT Output Completion Date Order					
i) Element Level		**		**	**
ii) Minor Task Level	*	*	*	*	*
iii) Major Task Level	*		*		
Resource Loading Reports (Minor Task Level)		**		**	**
Resource Loading Displays (All Activities)	**		**	**	
Milestone Reports					
i) Major Task Level	**		**	**	
ii) Phase Level	*		*		
Scheduled Outlook Displays					
i) Major Task Level	**	**	**	**	**
ii) Phase Level	*		*	*	
Cost Progress Reports					
Work Packages		**		**	**
Major Tasks	*	*	*	*	*
Phases and Above	*	*	*	*	

SCHEDULE AND COST MONITORING REPORTS (UK)

Figure 15

carried out every four to six months and the decision as to the amount is taken as a result of a meeting between Project Officers and other senior Department of Defense officers.

Leading up to this meeting there are several reports. The contractor produces a report which details the technical, managerial, cost, schedule and performance achievements during the period under consideration. It is a weil produced and readable report which presents the case for the contractor. In addition, reports are received from Department of Defense facilities such as test and experimental centres that have had dealings with the project, trial ships and the Technical Representatives at the contractor's plant. On the day of the Award Fee Meeting,the contractor's project manager makes a presentation and various Department of Defense officials are interviewed. Apart from the prime reason of awarding a fee, a thorough evaluation of the project is accomplished. In the process, the relevant information on the project is passed to those who need it,and overall, the process is handled swiftly and efficiently. As an example of award fees, those for the SM-2 development contract are shown in Figure 16. The overall average represents about 75% of the maximum award fee.

B. INFORMAL INTERACTIONS

Interactions that are not official are, for the purpose of this thesis, termed informal. Most correspondence between a project office and a contractor is by formal letters and

SM-2 Development Contract

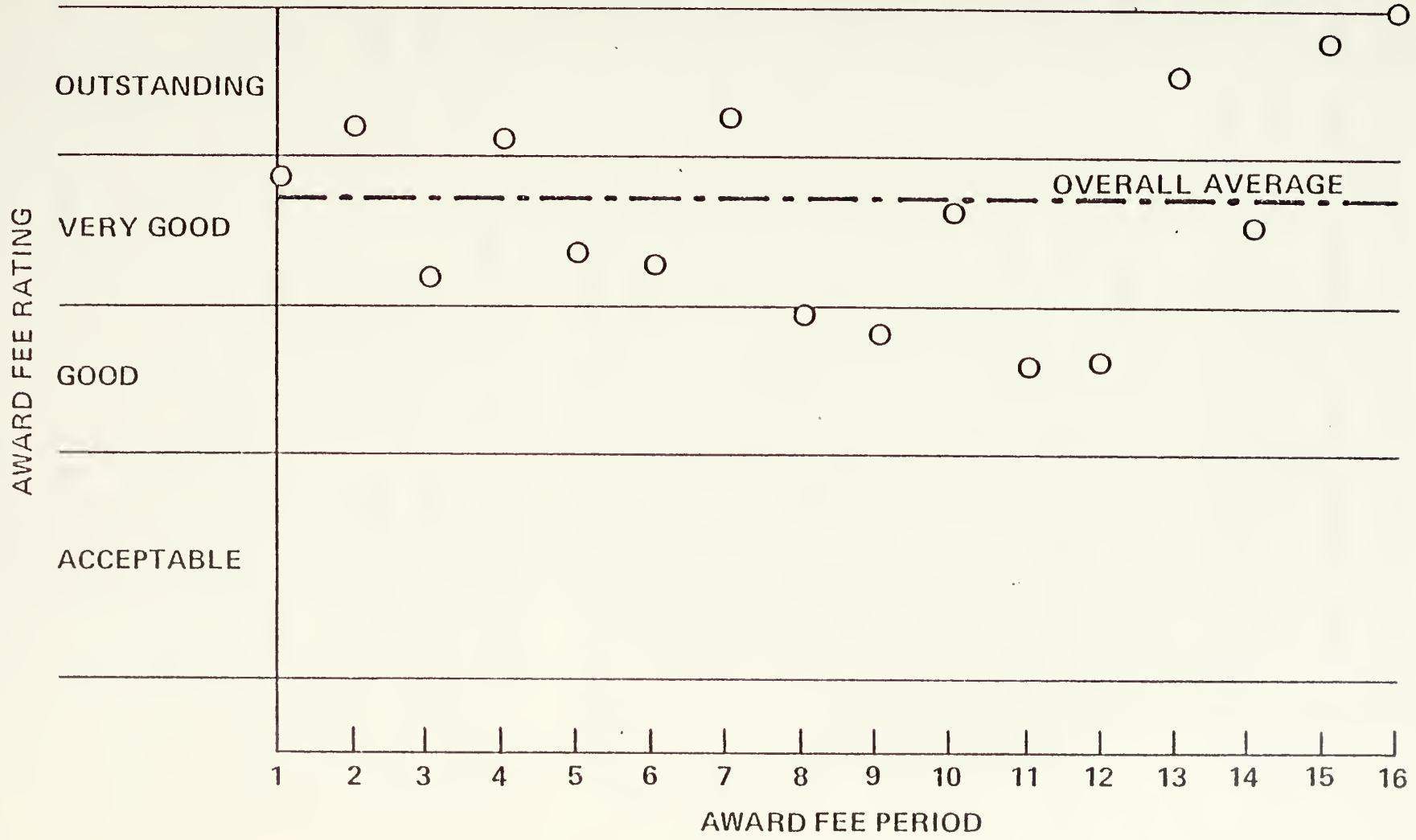


Figure 16

reports which are considered official interactions. There may be some informal correspondence, probably hand-written memoranda or preliminary results of tests, but the majority of informal interaction would be by meetings or telephone conversations.

In Britain, the proximity of contractor to project office makes it very easy for impromptu meetings to be called. The majority of these meetings are called by the project office or other branches of the Ministry of Defence and can engage a significant proportion of a contractor's manpower. As an example, a project manager of Marconi Radar Systems Ltd. once stated that on his project there were over thirty meetings with the Ministry of Defence in one month. For this type of situation to exist, it is likely that either a contract is ambiguous with requirements not clearly defined, or that the project office is attempting to oversee the contractor at too fine a detail.

In the United States, the informal interactions are less obvious but still exist. Due to the greater distances there is less opportunity for the impromptu meeting and it is less frequently that the project officers visit the contractor. In the case of the SM-2 missile, the project manager visits the contractor between every two weeks to two months. On the other hand there is much informal interaction between the resident 'Technical Representive' and the contractor. It is inevitable that during the course of their daily work, the 'Technical Representative' and his team of engineers will

discuss the progress of the project in general, and any problems in particular. On a rather more formal basis, in the case of SM-2, a weekly meeting is held between the 'Technical Representative' and the contractor's Project Director. This is an informal meeting with no minutes taken and, unless there is some particular problem or event, no communication sent to the project office.

C. DEFENCE AGENCIES' VIEWS ON INTERACTIONS

In earlier chapters, the market conditions due to the different sizes of the respective defence industries were discussed. It is now necessary to present the differences in interactions due to these different sizes. In the United States, systems acquisition is run on very much more commercial lines. By this, it is meant that the Department of Defense is not particularly concerned with the welfare of the contractor. The Department of Defense requires a viable defence industry as a whole but is not concerned that an individual contractor lost heavily on a particular contract.

On the other hand, in Britain the Ministry of Defence is concerned about the welfare of contractors as they may well be the only ones of their specialisation. Therefore greater emphasis is placed on collaboration and partnership than in the United States. As an example it is stated in a publication on guidelines for pricing:

> 'that it is now necessary to encourage greater reliance on the presumption of good faith in any price agreement' (Ref. 23).

Also to further the partnership it is proposed that the Ministry of Defence employ businessmen, for relatively short periods of time, in order to move closer to the business community. (Ref. 22).

D. INDUSTRIES' VIEWS ON INTERACTION

It appears to be the views of contractors both in the United States and Britain that the respective project offices become too involved in the day to day detail of the programmes. This is despite what was described in the section on 'Official Interactions' where it appeared that in the United States the contractor was left more to the day to day running. In Britain the investigation of variances at the element level are seen by industry as normally not cost efficient. Also, despite the atmosphere of a partnership in Britain, it is the opinion of industry that the Ministry of Defence distrusts industry, and as a result requires vigorous supervision of contracts. This is resented by industry and causes extra costs and long delays. (Ref. 22)

Another point that was highlighted in discussions with contractors in Britain was that of the skills of the project team members. The majority of personnel in project teams are civil servants with technical training and therefore financial implications are not properly considered with respect to technical performance. With regard to Naval officers who form the rest of the team, they are all of a technical specialisation and so performance is even more the prime requirement.

Finally, concerning arms exports in Britain, industry has resented the intrusion of government into salesmanship which it regards as so commercial as to be beyond the competence of government. (Ref. 24) However, despite these views, it is essential that industry and the government maintain full cooperation in export drives, as it is normally the military forces which demonstrate the weapon system for the contractor or whose requirements are biased towards the potential for exports.

VI. PROJECT MONITORING AND CONTROL

The purpose of project monitoring and control is to provide visibility to progress and to strive for an optimum balance between cost, performance and schedule of an acquisition programme. The more efficient and honest that organisations are and the more closely defined the requirements, the less would be the need for monitoring and control. However in the real world where few things are perfect, monitoring and control are necessary.

The major emphasis of this chapter will be on the control of a contractor by the project office and will be from the perspective of what should be required by the project manager.

It is often stated, both in the United States and Britain, that: 'the contractor is paid to manage.' However, in truth, it cannot be said that this is what happens in real life. Instead a contractor runs a cost and schedule information processing system with the majority of significant management decisions being taken as a result of discussions with the project office personnel. These project office personnel carry out a check of the contractor's cost and schedule information that they are continually provided. With this information, and as they are in an authoritative position, they tend to make many more of the management decisions that should be made by the contractor.

The proper position for a project office is to control the prime contractors where project cost, schedule and performance are involved and to act as the coordinator between prime contractors and the other various defence agency departments that affect the project.

A. THE OFFICIAL COST AND SCHEDULE GUIDELINES

In Britain, the guideline is the Handbook of Procedures-Programming, Estimating and Control of Development Projects, (Ref. 20) and in the United States it is DOD Instruction 7000.2 (Ref. 25). However, while the handbook is only a guide for British projects, in the United States, compliance with the DOD Instruction is mandatory.

1. The Handbook of Procedures - Programming, Estimating and Control of Development Projects

This handbook was compiled as part of the Downey Report (Ref. 5) and provides a very detailed method of controlling the work of a contractor. The scope covers: Project Definition, Development Programming, Development Cost Estimating, Monitoring and Controlling Technical and Cost Progress, Unit Production Cost Estimating and the Recording and Analysis of Data. In each of the above sections, recommendations are made as to the actions of the project office; the work required by the contractor; the reports and other outputs required by the contractor; the proportion of funds that should be expended; and the position the project should attain as regards development and risk.

In the sections on Monitoring and Controlling Technical and Cost Progress, a very detailed management system is described for use by the contractor. It is a PERT system with the major emphasis on PERT/Time. Costs are estimated, collected and analysed but a cost schedule trade-off analysis is not performed in accordance with PERT/Cost.

As stated above, compliance with the handbook is not obligatory and therefore PERT does not have to be used. However, when a contractor is making a proposal, he must come to an agreement with the project manager as to the monitoring system to be used. As the Project Manager will have been trained with the PERT system, the agreed monitoring system is unlikely to differ from it very much, although it may be under a different name.

2. DOD Instruction 7000.2 'Performance Measurement of Selected Acquisitions'

The instructions laid down in this mandatory document apply to all new major acquisition contracts since its promulgation in 1972. However, this document, and any related to it, does not lay down detailed management systems that a contractor and project office must adhere to. Instead, it aims at a means of control that will provide standard information on progress at a level that can be understood. As quoted in DOD Instruction 7000.2, there is an objective:

> "To provide an adequate basis for responsible decision making by both contractor management and DOD components, contractors' internal management control systems must provide data which (1) indicate work progress, (2) properly relate cost, schedule and technical accomplishment, (3) are valid, timely and auditable, and (4) supply DOD managers with information at a practicable level of summarization."

As long as a contractor's internal management system is shown to satisfy these objectives, no change to its system is required. It is also specifically stated that the contractor is to provide performance data directly from the same system used for internal management and is not to run a second separate system for reporting to the government. In no place in the Instruction is PERT mentioned. This is because towards the end of the 1960's PERT became unpopular on defence contracts due to the short-comings in the system being recognised. In a major revision at the beginning of the 1970's, it was accepted that a contractor could use any method he liked so long as it met Department of Defense approval. Therefore, the word PERT was dropped, although to satisfy the Department of Defense a contractor's system still has to be very close to a PERT system.

B. THE IMPLEMENTATION AND OPERATION

1. Installing the Management System

This section describes the process necessary to ensure that a contractor's management system is capable of adequately monitoring progress, and of providing the required information to the project office.

In Britain, there is no common laid down requirement that contractors must satisfy before being eligible for a defence contract. Instead, during Feasibility Studies (which equate to the U.S. Conceptual Phase) a contractor should include in its contract proposal, a proposed management structure and a statement as to its willingness to meet the requirements of monitoring and reporting (Ref. 19). Once selected as the contractor for Project Definition (equates to U.S. Validation Phase), it is necessary for the project office and the contractor to come to an agreement on the exact system to be employed. This then becomes part of the Development Cost Plan. In the case of the Seawolf missile contract, it was agreed to implement the Downey proposals to the fullest extent possible. This was the first time that the Downey proposals had been used on a major contract.

In the United States, before a contract is awarded, the prospective contractor must satisfy the Department of Defense that it meets, or is able to meet, the criteria of management control required. These criteria are stated in DOD Instruction 7000.2 (Ref. 25) and are known as the Cost/Schedule Control System Criteria (C/SCSC). There are thirty-five of these criteria which are divided between organisation, planning and budgeting, accounting, analysis, and revisions and access to data. These criteria are amplified in the C/SCSC Joint Implementation Guide (Ref. 26). The principle is that: a contractor must be consistent in his method of

managing; the total contract must be broken down into separate units of work; the costs of labour, material and overhead must be identifiable to each unit of work; both the estimate and actual cost of work must be summarised upward; differences between planned and actual progress must be clearly presented; and contract changes must be speedily and consistently processed.

For a contractor's management system to be approved there is a process of evaluation to be carried out. However, once the system is approved, it is good for any further contract subject to there having been no changes to the system. The instrument that effects this is a Memorandum of Understanding which is an agreement between the contractor and the defence agency. In it, the latter approves of the system while the former agrees not to make any changes without approval.

In order to gain initial approval a contractor must submit to a series of reviews. The initial one is the Evaluation Review which is carried out before a contract is awarded to evaluate how a contractor plans to comply with the criteria. If awarded the contract, the contractor must then submit to a series of reviews which leads up to the Demonstration Review. This review is presented by the contractor as a demonstration that he is complying with the criteria. Once accepted, there then continues a surveillance review during the course of the contract to ensure that the management system continues to meet the criteria.

It is interesting to note that the SM-2 missile contract with General Dynamics is an exception to the rule in that it does not comply with the criteria. It appears that the requirement was waived by a senior Department of Defense official, and it is presumed that the main reason was because the SM-2 was a modification to the SM-1, which had been in development and production for some years. However, it appears that General Dynamics will have to comply in the near future if they wish to win further Navy and Army contracts.

2. The Development Plan

Whereas in the United States much work is carried out in evaluating a contractor's management system, in Britain the effort is put into producing a detailed development plan for each contract. It appears that in the United States the contractor is normally left to devise more of the detail of the plan such as work package size and schedule, and must only seek approval from the project office of milestones and major tasks.

In Britain, the Development Cost Plan is developed during the two stages of Project Definition by the contractor with assistance, and the approval, of the project office. The plan is developed in two stages. At the end of PD1 the plan should show the detail of tasks proposed for PD2 and a broad appraisal of the work in full-scale development. This should include an overall PERT/Time network. Also required are cost estimates for the above activities and an estimate

of unit production costs. Although these estimates are only tentative and will be updated later, the contractor is forced to start thinking about the units of work and related costs at an early date.

By the end of PD2, the contractor must produce a detailed management plan and Development Specifications. The Development Specifications are broken down into: the Performance Specification, which becomes part of the Naval Staff Requirement; the Development Trials Specification, which is used as the basis for acceptance into service; and the Engineering Characteristics Specification. This last one describes the hardware and is used for estimating production costs. The management plan must show a break down of work during full-scale development to the Work Package level. It must include costs of labour and materials at this level, with the schedule being shown by PERT/Time networks. The requirement to produce such detailed planning information was a result of investigations carried out for the Downey Report (Ref. 5). Many contractors had stated that specifications had not been adequately defined prior to contract award. This led to the inability to plan ahead and resulted in poor costs and schedule estimates.

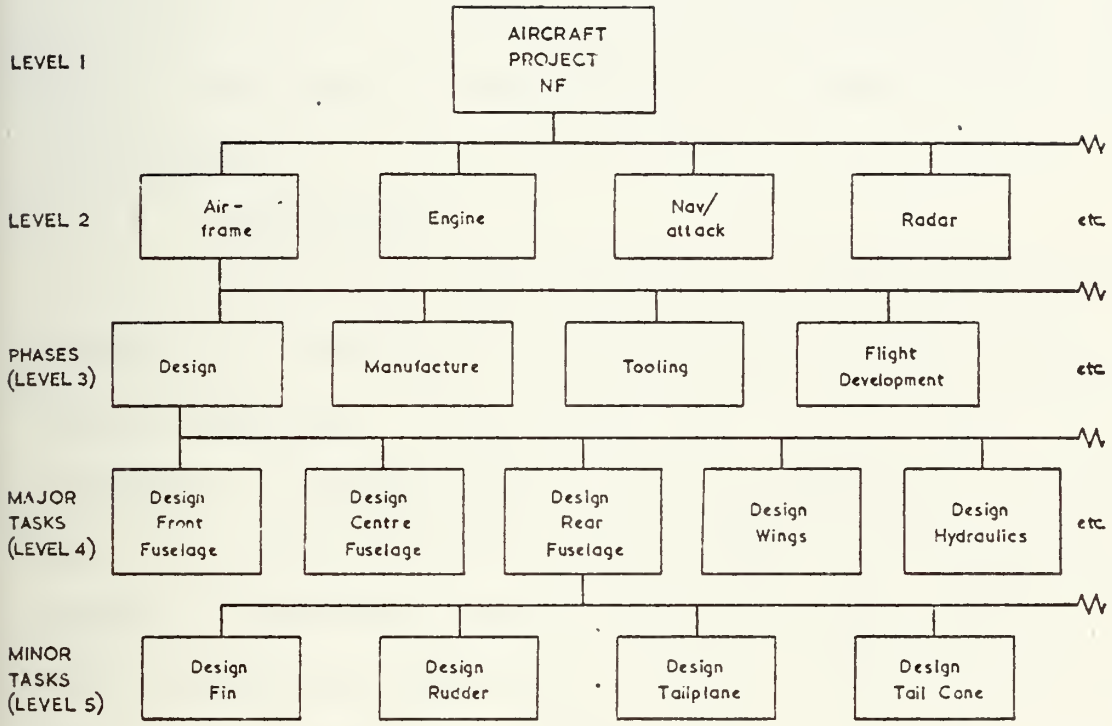
3. The Work Breakdown Structure

This is a system whereby a complete project is broken down through several stages into small units of work. A typical example of part of a Work Breakdown Structure is

shown in Figure 17. The problem is at what level should a project office become involved during routine monitoring?

In Britain, in the Handbook of Procedures (Ref. 20) it is recommended that the regular monthly reports contain detail at the Work Package level (level 5). Further, it recommends that the cost of a Work Package is between £10,000 and £50,000 and its duration should be not more than three months. However, in the United States, the value of a Work Package is not specifically stated and its duration is recommended as not to exceed two reporting periods (approximately six months). This is because the Cost/Schedule Control System Criteria does not require the project office to become involved at this level and therefore it is of limited concern to the project office how the contractor controls the project at the Work Package level.

There is much discussion in Britain as to the size of a Work Package and to the level of project office control. Opinions were received from project managers in both industry and the Ministry of Defence either from interviews or documented presentations and these showed that there was no consensus on either side. It was generally considered that the time level of three months was unrealistic and resulted in hypothetical events. A more realistic time was between six months and a year. A limit on the cost of a Work Package was considered of lesser importance and varied between £10,000 and £100,000. As an example, for the Seawolf missile



WORK BREAKDOWN STRUCTURE - EXAMPLE

Figure - 17

the aim of a Work Package was to be of duration three months and value £10,000. This resulted in 55 major tasks and 1500 Work Packages.

A further point that came out was that in general, industry considered that the project office should only look at the Major Tasks (level 4) for routine monitoring, with data on lower levels being available if required for closer investigation.

4. Monitoring

To monitor the progress of a project there must be a focal point where all the information on each individual task is gathered. To be of any use, it must then be clearly presented in a manner that is readily understood by management. In the cases where a PERT system is being used, the schedule information can be presented in two reports, the PERT Output-Float Order Report and the PERT Output-Completion Date Report. The former shows the extra time available to complete each unit of work in isolation. Units with no extra time are on the critical path and those with negative quantities have slipped and unless corrective action is taken, the project completion date will be delayed. The PERT Output-Completion Date Report lists in order of expected completion date the units of work. This then is a guide to management as to which activities to observe in the near future. The unit of work that is reported is the element and in the case of the Seawolf missile there were some 10,000 of them. To

monitor all of these is not practicable and must at least be delegated to the managers responsible for each Work Package. In Britain reports are passed to the Ministry of Defence project manager but it is considered unlikely that his personnel would have the time to study them thoroughly.

With the Cost/Schedule Control System Criteria of the United States, a contractor collects similar information as in Britain but only reports variances between Budgeted Cost of Work Scheduled and Budgeted Cost of Work Performed. The level at which these variances are reported depends on their size. Individual large variances and an accumulation of small ones must be reported.

For cost reports in the PERT system, three options are given in the Handbook of Procedures (Ref. 20) for use in Britain. The first is the 'rate of spend' comparison, which compares actual costs to date with those budgeted to date. The disadvantage in this method is that costs are not related to actual work and therefore it may happen that costs are being incurred at a budgeted rate but work accomplishment is falling behind. In the case of the Seawolf missile, reports in this format were requested by the Royal Aircraft Establishment who were responsible for monitoring progress during the early stages.

With the SM-2 missile, a report of equivalent men employed at any one time is produced, an example of which is shown in Figure 18. This is effectively the same as a rate of spend as the majority of costs are labour costs.

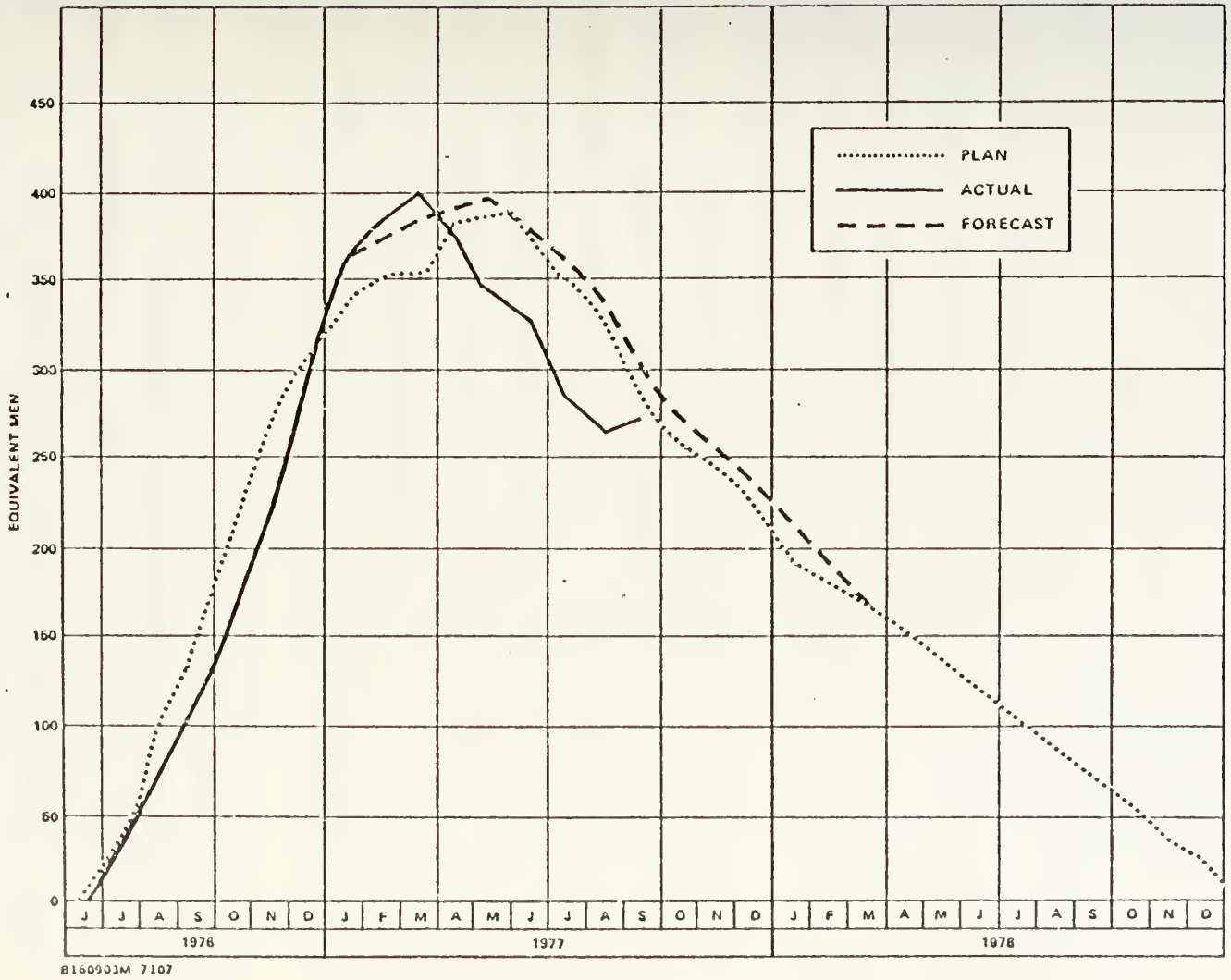


Figure 18. SM-2 Equivalent Men Employed.

The second method of cost reporting is the 'budget cost comparison' method. This compares the actual cost of work performed with the budgeted cost for that work. Therefore it shows whether the work is costing too much or too little, an over-run or an under-run. This method is required by the Cost/Schedule Control System Criteria, and in a manner similar to schedule analysis, only significant variances are reported to the project office. For the Seawolf missile and for the ship-borne tracking equipment, this was the method used for continuous week by week monitoring. For the SM-2 missile, this method was also used and reported in the monthly Cost Schedule Report.

The third method is the 're-estimate comparison' in which the budgeted cost to completion is compared to the re-estimated cost to completion. This method, although the most informative, is also the most time-consuming if used for weekly or monthly monitoring. However, updated estimates for future work are required, though in practice these are done at less frequent intervals, being between six weeks and three months.

In the discussion so far, it has been assumed that the performance achieved is as specified and that no change to cost and schedule is considered for either over- or under-achieving. This third factor to cost and schedule must always be borne in mind, although to project managers in industry or the defence agencies, changing this variable is not normally within their authority. Improvement or

relaxation of the specification are usually referred to the central staffs for decision and approval of extra funds where appropriate.

Finally, for a monitoring system to be effective, the information that it gathers and processes must be presented without delay if corrective actions are to be taken before too much harm is done. Therefore when monitoring the cost and schedule of elements it is essential that the data be presented to management within a few days of the end of the period as the duration of an element is most likely to be only measured in weeks. From discussions it appears that the delay from the end of a period to the data being available is about five days. As contractors increase their use of computerised monitoring of work in progress, this delay should be decreased which will benefit tighter management control.

5. Suggested Improvements

From interviews with project managers and from reading papers on managing defence contracts, various suggestions for improvements have been made. However, all of these suggestions concern how a summary of progress should be displayed for use by defence agency personnel. This would therefore imply that the present method is cumbersome for senior management within the defence agencies.

One suggestion by a past project manager of Seawolf is the use of a 'Status Index' (Ref. 19). This compares work and costs in the formula:

$$\text{Status Index (SI)} = \frac{\text{Work Achieved}}{\text{Work Planned}} \times \frac{\text{Estimated Cost}}{\text{Actual Cost}}$$

with all figures being related to the present period of time. A figure of greater than one means that value for money is being gained and vice versa. This formula can be rearranged to become

$$SI = \frac{\text{Estimated Cost of Work Achieved}}{\text{Actual Cost of Work Achieved}} = \frac{\text{Budgeted Cost of Work Performed}}{\text{Actual Cost of Work Performed}}$$

$$= \frac{BCWP}{ACWP}$$

Therefore this method presents a cost variance as a ratio as opposed to a pound or dollar term used in C/SCSC. It is suggested in Ref. 19 that the Status Index be evaluated for each Work Package, but if this is done it is difficult to summarise upwards. This is because Work Packages of differing values or importance must not be allowed equal weighting. If variances are expressed in pounds or dollars they can be accurately summarised by simple addition.

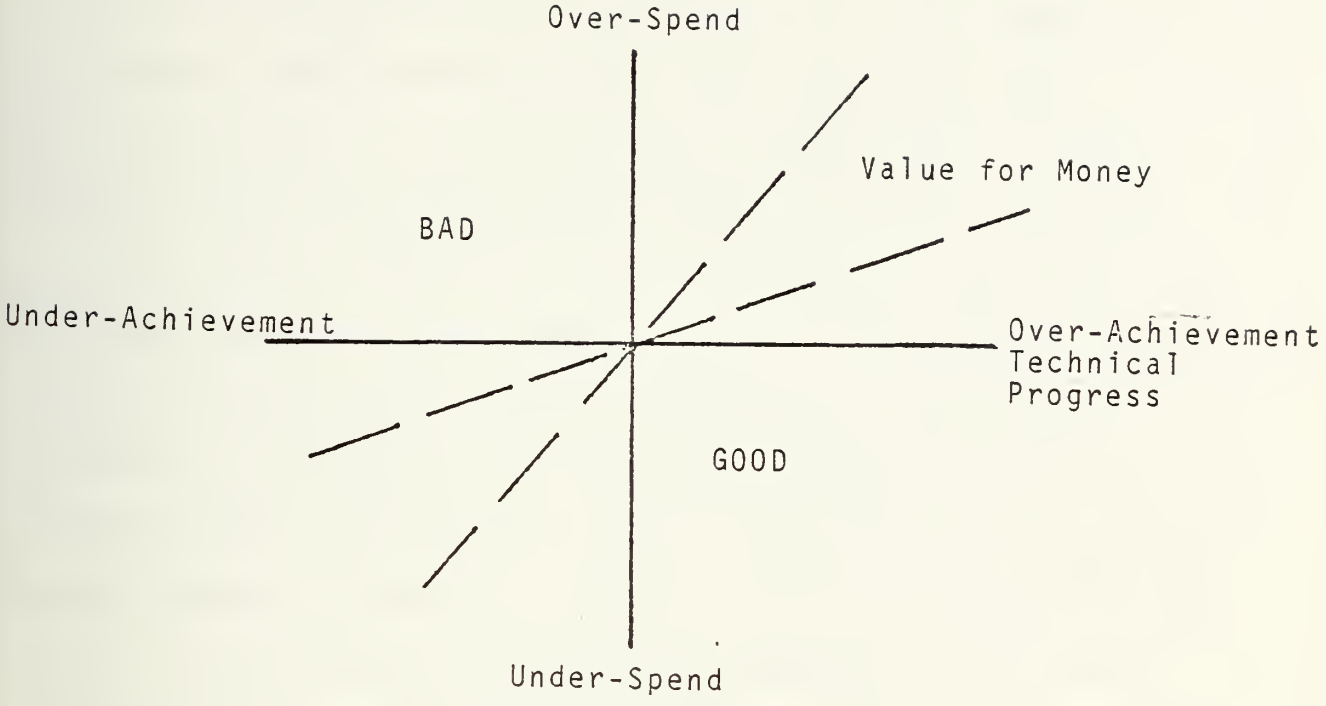
Other suggestions include the expanded use of graphical displays, the intention being to show the balance between cost, schedule and performance. The problem here is that it is difficult to display clearly a three-dimensional plot and therefore one of the parameters has to be assumed as constant. One such idea was presented at a PERT/Cost Symposium in Britain (Ref. 27) in which the effects of schedule variation were ignored. The representation was called a 'Rainbow Chart' and an example is shown in Figure 19. The problem with this method is that it is difficult

to quantify over- or under-achievement of technical performance. Also by what criteria are the areas of good, bad and value for money established. Another method variation is described in a paper from the United States Defense Systems Management School (Ref. 28). In this, performance is held constant while the balance between cost and schedule is displayed. Figure 20 shows an example. This graph would be easy to plot as numerical values are known for cost and schedule and would be a reasonably accurate representation of the three parameters, as in most projects the performance is virtually fixed.

Another graphical display suggested as a means of monitoring the contractor's ability to keep to schedule is to have a histogram of the number of Work Packages late by the number of weeks. While this may be a good instrument for displaying a contractor's inability to estimate schedule, it has little bearing on the completion date of the project.

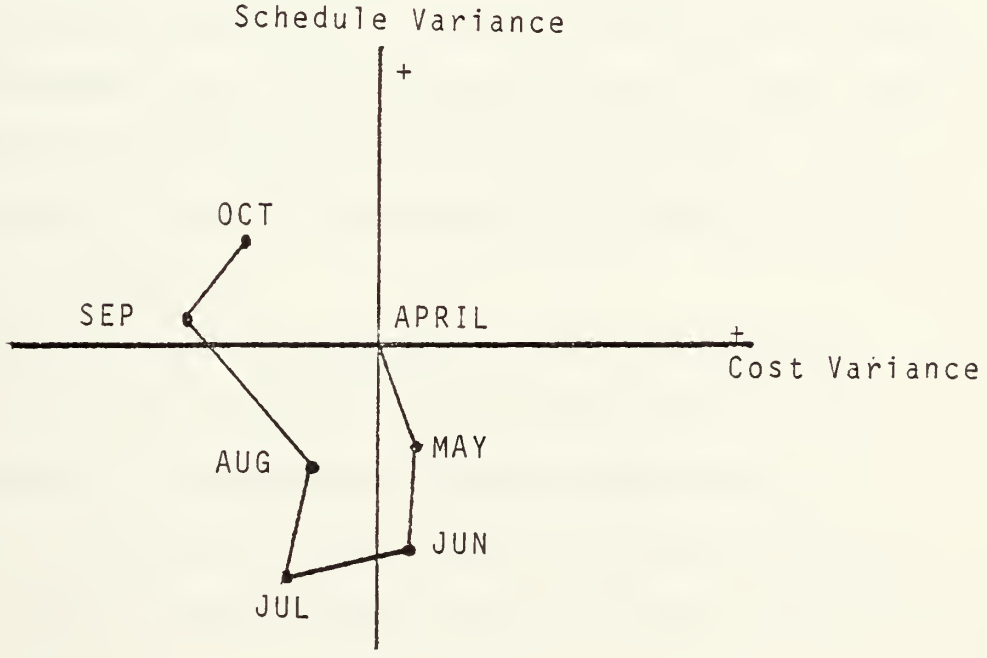
6. Trade-Off Decisions

One of the major responsibilities of a project manager is to produce a plan for the project and then to see it is carried out to the best of his ability. This implies that when the project does not run according to cost or schedule, the project manager must make trade-off decisions between cost, schedule and performance. It can be said that if one of these parameters changes for the worse it cannot be rectified without a penalty to one or both of the other two.



RAINBOW CHART

Figure 19



COST/SCHEDULE VARIANCE CHART

Figure 20

An exception to this rule is if there is an improvement in efficiency, which implies either that the project had previously been run inefficiently, or that there is some slack in the project that had not been initially reported.

During the course of interviews in Britain and the United States, it became apparent that the importance of the three parameters were treated differently. As a general statement, in Britain it was apparent that the order of importance for meeting the original requirement was: performance, schedule, then cost, while in the United States it was: cost, then performance and schedule together. In Britain, changes to the performance specification are unwelcome by the project manager as they would often have to be approved by the central staff and the users, thereby giving publicity to the problems of the contract. If cost is allowed to increase, the project manager has a 10% tolerance before he need report it to the central staffs and also the cost problem need not involve the users. Also, in these days of inflation, cost escalation is not unusual.

In the United States, the life of a project is controlled by whether Congress appropriates the necessary funds. Therefore, if there are problems with a project, having to go to Congress for more funds is avoided whenever possible for fear of very close scrutiny or even cancellation.

C. THE BENEFITS AND CRITICISMS

When something is imposed on an individual or an organisation and it is essentially against his wishes, any favorable comments by that individual or organisation can generally be trusted. In Britain and the United States, industry was reluctant to adopt the Downey principles and Cost/Schedule Control System Criteria respectively. Now that both have been in operation for some years,many benefits have been acknowledged as well as some criticisms.

The industries of the United States have acknowledged that the main benefit that has been gained has been overall system discipline. That is, industry has had to extend its management by functional managers to cover the entire project as controlled by the project manager. Other benefits seen by industry have been: the costing of earned value for work carried out in R&D contracts; detailed forward planning; increased visibility and control; improved communication, and increased cost/schedule awareness by engineers (Ref. 29).

From the industries of both Britain and the United States the major criticism is the level of detail of information that the contractor is expected to collect and have available to the project office. Another point that they criticise although it is not to their own financial loss, is the cost of implementing and running such a detailed system. From the interviews, estimates of costs for management services varied from 2% to 10% and the paperwork load was considered very time consuming.

D. PERT/COST

PERT/Cost is an extension of the PERT/Time system and enables managers to cost the effects of accelerating a project. To be able to do this, cost estimates for each Work Package must be calculated for working at a normal rate, and for working at an accelerated, or overtime, rate. Estimates must also be produced of the cost of speeding up deliveries and work from subcontractors. The object is to calculate how much it would cost to reduce the duration of a Work Package by a varying number of weeks. As contractors have difficulty in estimating costs at a normal rate and complain of the work load in doing it, they are certainly not enthusiastic at doing it several times for different degrees of acceleration.

Having calculated the costs of acceleration for each Work Package, the theory of PERT/Cost says that the cheapest way of accelerating the whole project is then calculated. This is done for different quantities of acceleration by accelerating those Work Packages that are the cheapest in terms of money for project weeks saved. The object here is that if a project manager wishes to accelerate the project, or more likely to regain some slippage of schedule, the cheapest way of doing it is presented to him from PERT/Cost data. Therefore if a project schedule has slipped the manager may decide to accelerate some Work Packages later on in the programme. However, in real life, it would be a brave project manager who, on finding that the schedule has

slipped, would defer recovery action until a time that might be towards the end of a project. This then is one problem in the use of PERT/Cost, and while project managers are human this problem will not be overcome.

VII. SUMMARY OF FINDINGS AND CONCLUSIONS

This Chapter presents in summary form the differences found during this investigation.

As a general statement, it can be said the process of major system acquisition, or procurement, and the method of control exercised by the respective defence agency on a contractor are similar. However, there are differences, some of which can be explained by the different characteristics of the countries and some by the fact that there are two equally good ways of operating. On the other hand, there are some differences which, in the opinion of the author, it would be beneficial for one country to heed from the other. These latter differences are described at the end of this Chapter.

A. SUMMARY OF FINDINGS

The differences are shown in the following comparative lists:

CH	ROYAL NAVY	UNITED STATES NAVY
III A	The producer organisation under the Controller of the Navy is in parallel with the user under the Chief of Naval Staff. The Naval Projects Committee, which is the most senior naval procurement committee, is heavily producer oriented. The Vice Chief of Naval Staff is the only user. User/producer dialogue is officially encouraged from before the Naval Staff Target is drafted.	The producer organisation, under the Chief of Naval Material, is subservient to the user, under the Chief of Naval Operations. Within the Navy, final approval for project initiation or continuation is given by the Chief of Naval Operations. Under the revised DOD Directive 5000.1, the user/producer dialogue officially starts after the Mission Element Need Statement is written but typically starts before informally.
III B	NAVSTARCODE provides the basic guidance on the procurement process.	DOD Directive 5000.1 provides the basic instructions for acquisition within the Department of Defense There is a formal and visible process of programming and planning from the President downwards.
1		

	ROYAL NAVY	UNITED STATES NAVY
2	Industry is used for defence oriented research more than in the United States.	There are moves towards using industry more for defence research but the Navy Laboratories are concerned that their position will decline. If more research is carried out by industry, Congress and the public will take more interest on how the funds are spent.
3	Pre-feasibility Studies are carried out to satisfy a particular need that it is highly desirable to develop.	Advanced and exploratory development is carried out on several aspects and their selections are made for further development as the need and funds arise.
4	Industry is involved in drafting Naval Staff Targets. Naval Staff Target is approved by the Naval Projects Board and the Operational Requirements Committee of the central staff. More emphasis is placed on decisions by committee.	Mission Area Need Statement is approved by the Chief of Naval Operations and the Secretary of Defence. More emphasis is placed on decisions by a particular position or named individual.
III C		
1	Co-development with NATO increases the time for procurement due geographic separation; different languages and technical conventions; and problems of balance of payments.	Co-development with NATO and possibly other countries, e.g. Middle Eastern countries, should not be ignored despite short-term disadvantages. Buy America Act directs that the Department of Defence may only buy foreign

		ROYAL NAVY	UNITED STATES NAVY
			products if either there is a price advantage of at least 6% or that the product is not available in the United States. However, this may change.
III	D	Industry influences the characteristics of what is acquired due to the desire for foreign sales.	
IV	A	It is recommended in the Downey Report that 15% of total development funds be spent prior to Full-Scale Development. The Project-Definition phase is divided into two parts with 5% and 10% of development funds being spent in each.	Similar requirement is recognised.
	1	There is concern at the high turn-over of senior project staff, especially military officers. Guidance Handbook for Project Management - gives detailed guidance to project managers on day-to-day management.	A similar concern is expressed. It is directed that the Program Manager should only change during the Validation and Production phases. Department of the Navy, Programming Manual - gives details of Planning, Programming and Budgeting System and processing of documents. The need for a Project Manager's Guide has been recognised.

	ROYAL NAVY	UNITED STATES NAVY
2	Naval Staff Targets are circulated to several industries. Feasibility Studies are carried out by a few contractors followed by one being chosen for further development. The lowest bidder need not be chosen.	Studies during the Conceptual Phase are often carried out by several contractors. Lowest qualified bidder after negotiations is normally selected.
		Revisions to the Conceptual phase sequence is still under review due to introduction of MENS. Conceptual phase has an additional iteration of approval for the acquisition strategy.
3	Naval Staff Requirement is fixed before Project Definition begins.	Decision Coordinating Paper written before the Validation Phase starts is periodically updated, becoming more closely defined as the project continues. It is finalised at the start of Full-Scale Development.
	During approval of NSR, project manager is only called to answer queries on 'Submission'.	Project Manager is required to make presentations to the Navy Systems Acquisition Review Council and Defense Systems Acquisition Review Council.

	ROYAL NAVY	UNITED STATES NAVY
	After approval by central staff committees, funding must be requested from Treasury. Treasury normally supplies full amount Parliamentary oversight is exercised by the Parliamentary Select Committee on Expenditure - Defence and External Affairs Sub-Committee.	Budgets are approved by the Defence Authorization Bill and funds are released by Congress through the Defence Appropriations Bill and the House and Senate Appropriations Committees. Funds are often released for lesser amounts than requested.
IV B	Contracting carried out under English Common Law.	Contracting carried out under the Armed Services Procurement Regulations. Contracting Officer of the government can by law make a unilateral change to which the contractor must abide and perform. The contractor is able to subsequently appeal for price adjustment.
	Project Manager or his delegated official is the only person who may contract.	A Contracting Officer, not the project manager, is appointed to a project and is the only person authorised by law to contract.
	Competition between contractors is limited due to there being only one or a few contractors in each field.	Competitive proposals are required. If it is intended to negotiate with only one contractor for system design, prior approval must be gained from the Secretary of Defense and Congress must be informed.

		ROYAL NAVY	UNITED STATES NAVY
		As free market conditions are not possible due to lack of competition, the Ministry of Defence has negotiated with the Confederation of British Industries a profit formula. It is intended to give the average contractor 18% return on capital employed.	
		Profit incentives are only negotiated for cost reductions. Schedule and performance incentives are considered too cumbersome.	Profit incentives are negotiated for cost, schedule and performance. Some contracts have incentives of Award Fees as opposed to Incentive Fees. In this, Department of Defense officials award a profit fee on their subjective judgment of the contractor's overall performance.
		Tender and contract prices are confidential.	Contract prices are required by law to be published.
IV	C	Administrative delays between phases of 6-9 months. During this time the contractor will not commit resources in preparation for the next phase, despite Interim Funding.	Delays of 6 months - 1 year during the Source Selection process. During this time a small team is normally funded for continuity.
V	A	There are more meetings directly between the contractor and project office.	There are relatively few formal meetings, progress being monitored by the Technical Representative at the contractor's plant.

	ROYAL NAVY	UNITED STATES NAVY
	Normally, there is a monthly contractor's progress meeting to which a member of the project team is invited. There is a quarterly cost and technical progress meeting chaired by the project manager. There are many reports, in great detail, on cost and schedule progress.	Progress monitored during Award Fee Review process and by technical reports.
V B		There is much informal interaction between the Technical Representative and the Contractor.
V C	Collaboration and partnership between industry and the ministry of Defence is encouraged in order to protect the limited resources. It has been suggested that Ministry of Defence should employ business men for short periods, in order to improve relations and as an information exchange process.	Relationships between industry and the Department of Defense are on more commercial lines due to better free market conditions. As a result, the Department of Defense is not generally concerned about individual contractors' well-being, except when a major contract may be defaulted.
V D	Industry thinks the Project Offices are too deeply involved in day-to-day management of the contractor.	Similar opinions are expressed.

	ROYAL NAVY	UNITED STATES NAVY
	Industry believes that the Ministry of Defence distrusts them and therefore imposes unnecessary checks. Majority of profit office personnel are technically oriented. Industry resents the Ministry of Defence trying to act as an arms salesman.	
VI A 1 2	PERT/Time system of management is detailed as the method to be used in the Handbook of Procedures.	C/SCSC does not specifically state that PERT/Time must be used. However, the outputs required by C/SCSC dictate that the system used must be very similar to PERT/Time. C/SCSC only requires that: the contractors system must be valid timely and auditable; indicate progress; relate cost, schedule and performance; and supply DOD managers with information at a practicable level of summary.
VI B 1	Details of the management system and project plan are finalised during the Project Definition phase. The details become part of the Development Cost Plan.	Before contract award a contractor must show willingness and capability to comply with C/SCSC. To satisfy C/SCSC the contractor is subjected to an Evaluation Review to establish that it is capable, and then a Demonstration Review to show compliance. Once qualified for C/SCSC, a Memorandum of Understanding is signed which is a certificate of compliance for future contracts.

	ROYAL NAVY	UNITED STATES NAVY
3	The Handbook of Procedures recommends that Work Packages should be between £10,000 and £50,000 and should not be more than 3 months duration. It is considered by industry that a 3 month limit produces unrealistic and hypothetical events. Work Package duration of between 6 month and 1 year would be more practicable. Industry considers that the project office should only look at Major Tasks, as opposed to Work Packages and Elements.	It has been recommended that Work Packages be no more than two accounting periods. This would normally be 6 months.
4	Raw PERT data is supplied to project office in detail. 'Rate of Spend' information often used although it does not indicate progress. 'Budget Cost Comparison' information used extensively.	Reports supplied of variance analysis, showing individual large variances and accumulations of small ones. Similar information generated. C/SCSC requires outputs in the form of 'Budget Cost Comparison'.
5	Improvements suggested, concentrate on improved summary information, implying that present formats are inadequate.	A similar situation exists.

	ROYAL NAVY	UNITED STATES NAVY
	A Status Index is calculated for each Work Package to show cost versus technical progress. The figures accumulated for the separate Work Packages cannot be summarised easily due to their different sizes.	
	More use of graphical displays has been suggested to display cost, schedule balance.	A similar situation exists.
6	Performance is of prime importance in the trade-off with cost and schedule. Schedule is next and then cost last.	Cost is of prime importance with performance and schedule of equal secondary importance.

B. CONCLUSIONS AND RECOMMENDATIONS

1. OMB Circular A-109 (U.S.)

The recent introduction of OMB Circular A-109 has correctly emphasised that a need should be firmly established at the beginning of the acquisition process. The introduction of the Mission Element Need Statement brings the U.S. process more in line with that practised in Britain where a Naval Staff Target has been required for several years. However, full implementation of OMB Circular A-109 by U.S. agencies is still in process, and until it is completed and experience gained from its use, its full impact will not be known.

2. User/Producer Dialogue (U.S.)

A user-oriented Mission Element Need Statement is required, whereas previously the operational requirement had been heavily influenced by the technological input.

In order to maintain a balance between the user needs and the technology base, represented by Navy laboratories and industry, it is recommended that a user/producer dialogue be actively encouraged during the preparation of a MENS.

3. Co-development (U.S.)

The short-term disadvantages of adverse balance of payments and trading of technological superiority will be surpassed by the long-term advantages of a continuing arms market and of the sharing of development costs.

It is recommended that co-development projects with NATO and other countries should be further encouraged.

4. PERT/COST (UK)

The ability and willingness of contractors to estimate accelerated schedules for Work Packages is poor and the time and money involved in running the system would be great. Also, even if PERT/Cost information was available, managers would be reluctant to see slippages remain unchecked while waiting for the 'least costly' period to rectify them.

It is recommended that PERT/Cost not be implemented as a contractor's management system.

5. Work Packages (UK)

In the guide-lines on the use of the PERT/Time system, the recommended value and duration of a Work Package is too small so that some are divided up to create hypothetical events.

It is recommended that more flexibility be encouraged so that although many Work Packages will still be approximately £10,000 and of duration three months, others will be greater.

6. Progress Reports (UK)

It is considered that the volume of cost and schedule reports supplied to the project office in Britain, precludes them from being fully read and utilised.

It is recommended that more emphasis should be placed on summaries that highlight the critical problem areas through use of cost and schedule variance analysis. This would be more in line with the United States Cost/ Schedule Control System Criteria.

7. Status Index (UK)

The usefulness of a Status Index to express the cost performance of each Work Package is limited due to the difficulty of summarising them upwards to produce an overall Status Index.

It is recommended that it is preferrable to express cost performance in monetary terms.

8. Project Control (UK)

Contractors are not given, or do not take, sufficient responsibility for controlling a project, but instead carry out the directives of the project offices. This situation also exists in the United States to some extent. The problem is that the project office becomes too involved in the day-to-day running of the contractor's business.

It is recommended that contractors be given greater responsibility for the management and control of projects.

APPENDIX

OFFICIALS VISITED DURING RESEARCH

BRITAIN

Seawolf/GWS25 Trials & Acceptance	Officer	CDR D. Doidge
Seawolf/GWS25 Project Manager	Present	Mr. G. Halnan
Seawolf/Project Manager	Past	Mr. A.S.Martyn
GWS25 Project Manager	Past	Mr. J.C. Plowman
R&D Staff during Feasibility Studies		Mr. R. Forse
Seawolf/GWS25 Production Officer		Mr. Eccleston
Staff of Director Weapons Resources and Planning (Naval)		Mr. D. Taylor
Secretary to Naval Projects Committee		CDR E.W. de W. Waller
Naval Assistant to Director General Weapons (Navy)		CDR M. Millett
Head of Dept of Management Sciences R.M.C.S.		Prof M.A.Farley
Lecturer in Procurement Management, Portsmouth Management Centre		Mr. J. F. Winterbottom
Seawolf Project Manager, British Aircraft Corporation		Mr. J. Preston
GWS25 Technical Coordinator - Marconi Radar System		Mr. R. Towell

UNITED STATES

SM-2 Project Office	-Manager	Mr. E. Libby
	-Deputy for Engineering	Mr. R. Richard
	-Deputy for Plans and Administration	Mr. G. Allison
SM-2 Consultants	-The John Hopkins University Applied Physics Laboratory	Mr. W.M. Gray
SM-2 Technical Representative at General Dynamics (Pomona)		LT-CDR G. Bush
SM-2 Project Manager, General Dynamics (Pomona)		Mr. M.C. Keel
SM-2 Project Business Administration, General Dynamics (Pomona)		Mr. A.R. Young

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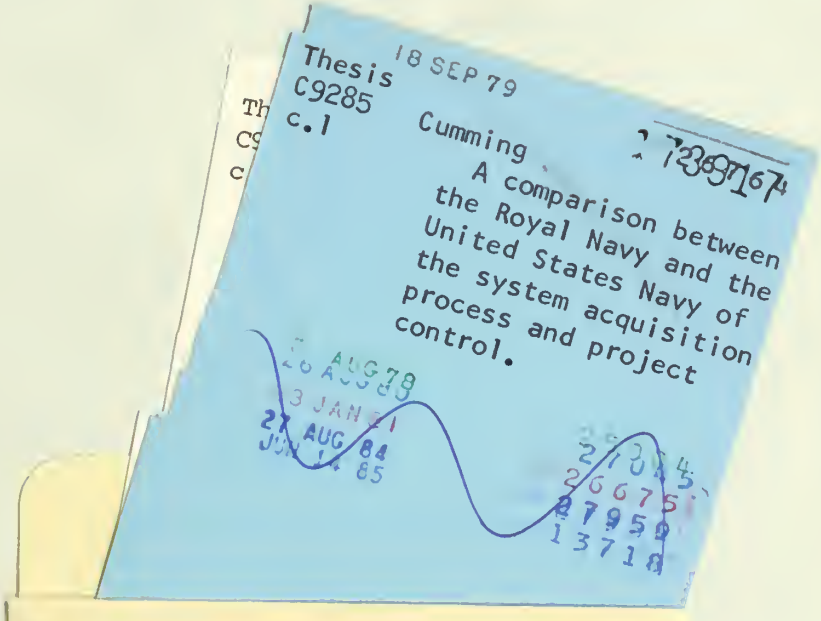

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